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The genre of research article abstracts: an analysis of abstracts of engineering science

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THE GENRE OF RESEARCH ARTICLE ABSTRACTS

--- An Analysis of Abstracts in engineering Science

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Abstract

Despite the fact that the writing of abstracts is an integral part of tertiary study, not much information regarding the linguistic nature of abstracts is available to assist students. This thesis intends to identify the characteristic linguistic features and their functions in three selected abstracts in the discourse of science and technology.

A set of three texts dealing with the field of English for science and technology have been selected for analysis. They have been analysed both at the text level or macro-level, clause and group level or micro-level, encompassing such aspects as schematic structure, Theme, cohesion, Transitivity, nominal group structure and nominalisations. The theoretical framework adopted for the text analysis is Systemic Functional Grammar.

As the analysis at text level shows, these abstracts reflect the generic structure of their source articles. It also indicates that cohesion is effected primarily through cataphoric reference. There is not much ellipsis and substitution. Most of the conjunctions are implicit rather than explicit. The lexical cohesion is primarily limited to relations of meronymy or hyponymy.

In terms of the language features at clause level, it was found that the Participants used in these abstracts are generic and metaphorical, and the Processes are mostly material and relational ones in the timeless present tense. The Themes are impersonal and experiential with few textual and marked themes. The analysis below clause level demonstrated a high frequency of lengthy nominal groups and nominalisations, whose function is to condense the meanings and to distance the reader and the writer. As a result of these long nominal groups and nominalisations, there is a corresponding high lexical density.

Although the analysis of the abstracts has shown some of the linguistic characteristics of abstracts, there are obvious limitations to the study in terms of the number of the texts analysed, the range of fields and the variety of analyse. Further studies are needed to complement this analysis.

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Chapter 1

Introduction

1. Background of the Study

This thesis will examine how Systemic Functional Grammar (SFG) can reveal the language features of academic abstracts in the discourse of science and technology, especially those linguistic features which appear in the abstracts of academic papers or theses. In particular, it will seek to describe how these language features serve to produce coherence and clarity of expression in the abstracts in which they occur, and how these language features are used in the texts in order to achieve the purpose of the texts.

Students at a tertiary level are often required to write papers, reports or theses for their studies. In writing these research articles, abstracts are always required. Thus, the question of how to write an effective abstract needs to be addressed. Although many books have been published to guide tertiary students in their academic writing, there is not enough advice that has been offered, in particular, on this specific topic of abstract writing. In the major books recommended for overseas students at tertiary level, such as "Academic Writing Course" (Jordan, 1990), "Studying in Australia - Writing Assignments" (Packham, McEvedy & Smith, 1985), "Read, Note, Write" (McEvedy & Smith, 1990) and "Developing Communication Skills - Assignment Writing" (McEvedy & Wyatt, 1990), nothing has been discussed on how to write abstracts.

Even those books in which the information of how to write abstracts is provided do not help students very much, especially overseas students. Their explanations of abstract writing are neither explicit nor clear enough in terms of how to write an abstract.

Typical of the advice to students is that an abstract consists of three parts: 1. a short statement of the problem; 2. a simple introduction to the method or procedure of their data collection; and 3. a condensed summary of the findings of the study. Moreover, an abstract should be short, and its length is limited to 200 words (Anderson, Durston & Poole, 1978: 50). What Anderson, Durston and Poole have stated about writing an abstract is similar to what is described by Graetz that an abstract consists of four parts, namely "Problem-Method-Results-Conclusions" (Swales, 1989: 181). To a certain extent, what they have claimed is functional. Nevertheless, it still sounds very superficial, providing a simple and general framework of an abstract. Such simple descriptions are not of much assistance to students, especially those non-English speaking background students. What has been neglected is the language features and the functions to realise those different parts in an abstract.

Most research articles are accompanied by a "homotopic" abstract (Swales, 1990: 178). The meaning of "homotopic" indicated by Swales is that an abstract can actually lead readers back to its original research article as they both bear the same topic but are presented to the readers through different ways. An abstract is written on the basis of widely-reported "anecdotal evidence" (Swales, 1990: 178). As it is claimed by Swales, an abstract is regarded as the "front matter and summary matter" (Swales, 1990: 181). It is because readers of research articles are "extremely fickle" (Swales, 1990: 179-181). Quite often readers will read an abstract before starting any further reading, since the purpose of an abstract is to help readers to grasp the content of its research article. Thus, abstracts function as "independent discourse" and the "advancing indicators of the content and structure of the following text" (Van Dijk, 1980, Cited in Swales 1990: 179). What has been stated is that an abstract has its own characteristics both in its way of presenting the meaning of its research article and building up its own schematic structure. As Bazerman states, an abstract acts as "one further step in turning the article into an object, for the abstract considers the article as a whole and then makes a representation of it" (Bazerman, 1984. Cited in Swales, 1990: 179). Swales refers to that as "distillation", the essence of

the genre (Swales, 1990: 179). It is due to this "distilled quality" that makes an abstract different from other types of writing.

What can be implied from the above is that abstracts, standing out as an independent discourse, should have their own linguistic characteristics in terms of the text structure, the language features and their functions. In other words, they are the representations of the research articles, however, they are different from any other writings. This distinguishes abstracts from other writings. The main factor which determines these differences is the "distilled" nature of abstracts (Swales, 1990: 179). An abstract is like a micro chip in which every element should be well condensed and packed. This purpose can be achieved by distillation. In the linguistic field, this distillation process requires that the language used in an abstract should be effectively condensed, and information well packed. Hence the language appears to be extremely abstract. It is this abstraction that Bazerman claims as the further step of "turning the research article into an object" (Bazerman, 1984. Cited in Swales, 1990: 179). It is also this abstraction that makes an abstract a new product.

Where an analysis of the language features has been undertaken, here still remain concerns and frustrations about what an abstract should be have been caused. Graetz from her analysis of 87 abstracts of various fields concludes that an abstract is distinguished by its tense and other aspects of the linguistic characteristics, ie. past tense, passive voice and other language features like sentence structure (Graetz, 1985: 125. Cited in Swales, 1990: 179). More detailed descriptions are provided that in writing an abstract, the following are to be noticed:

> The abstract is characterised by the use of past tense, the third person, passive, and the non-use of negatives. It avoids subordinate Clauses, uses phrases instead of Clauses, words instead of phrases. It avoids abbreviation, jargon, symbols and other language shortcuts which might lead to confusion. It is written in tightly worded sentences, which avoid repetition, meaningless expressions, superlative, adjectives, illustrations, preliminaries, descriptive details, examples, footnotes. In short it eliminates the redundancy which the skilled reader counts on finding in written language and which usually facilitates comprehension.
> (Graetz, 1985: 125)

Graetz shifts the description of abstracts to a new level, from the generic structure to the sentence structure, adding more details in terms of the language features, for example, the use of past tense, the expression of third person, passive voice, the use of phrases instead of Clauses and the use of words instead of phrases. Although more details on writing abstracts are provided, there are still certain limitations. It is primarily concerned with the conventions of language by listing the different rules and ignoring the functions which all these language features play in an abstract. An example of this is the dictum regarding the use of the past tense in abstracts depends on the stage of the abstract. In fact, the simple present tense is used frequently in the abstracts (See Appendix I).

As for other descriptions of the language features, different views are revealed by different researchers. In terms of using different tenses, Lois Malcolm states that the use of present tense occurs more frequently (Malcolm, 1987. Cited in Swales, 1990: 180). In Heslot's work, an abstract is considered as "commentary rather than in narrative of what was done" (J. Heslot, 1982. Cited in Swales, 1990: 180). The implication is that abstracts do not simply recount what has happened before, for example, using past tense. They also contain interpretation and evaluation. Swales regards the frequent use of the present tense in abstracts as a means which make the research reported "alive" and it reflects "wider knowledge-claims" (Swales, 1990: 180). It is due to the commentary and interpretation parts in abstracts that causes the frequent use of present tense. The following example shows the ways in which the researcher's commentary is penetrated with the use of simple present tense.

Example

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.

The underlined part in the example does not only imply the result or the findings from that study, but also claims the statement as a fact. Therefore, this phenomenon exists as a "truth" in that area of the study.

In summarising the descriptions above, a conclusion can be drawn that there is not yet a comprehensive account to guide students in the way which an abstract is written. Huckin's study (Huckin, 1987), Van Dijk's study (Van Dijk, 1980) and Bazerman's study (Bazerman, 1984) illustrate what an abstract is and the functions of an abstract in writing about science and technology. Graetz's study (Graetz, 1985) provides more details about the language features of an abstract. However, there are still many gaps that need to be filled. One question is what the basic structure of an abstract is, what the language features are and how the language features function in constructing an abstract. The different views about abstract writing stated by those researchers tend to treat structure, language features and functions as discrete elements. Currently, the area of abstract writing continues to be neglected with little research being carried out on the actual functional details of abstract writing. What is needed to be done is to discover a way which identifies these functions and makes them explicit, because condensing the meanings of a report, paper or thesis in an abstract requires a student to use the language at a highly sophisticated level. This can be difficult for language learners, especially those users who are from non-English speaking background. The attempt to identify the language features and their function in the writing of an abstract will make the ways of writing more explicit and clearer to language users or learners, including NESB students. It can be an effective means of guiding language users and NESB students to a more effective way of writing abstracts. This is the reason for undertaking the present study so as to discover more information about abstract writing.

2. Overview of the Thesis

This thesis consists of six chapters in all. Chapter One provides a brief introduction to the background of the thesis, including the purpose of this thesis, why to choose this topic and a brief overview of the research in the area of abstract writing.

Chapter Two will explore in detail the theoretical framework of the study and review relevant literature in this field.

Chapter Three provides a description of the methodology in this study, including the background of the subjects for this study, data collection, and procedure of the study.

Chapter Four presents a discussion of the abstracts in terms of genre and the relationships between the genre of the abstracts and the contextual variables of field and mode. The first part of the chapter will be about the analysis and discussion of the abstract's genre. The intention is to identify the purpose of each text and the schematic structure of the abstracts, so as to see how the purpose is realised through the different stages in the texts. The analysis of the genre and the schematic structure of the abstracts can provide an overview of the texts. The second part of the chapter will take the analysis of the genre into more detailed areas, by showing how genre and the register work together. In this part of the discussion, the contextual variables of field and mode will be covered. In terms of the field, the focus will be on the relationships between the genre and Participants and genre and Processes. In the discussion of the mode of the texts, the textual features will be identified and analysed. These textual features are organisation of Theme and Rheme which reveals the development of the information in the texts, and the cohesive elements, such as the Reference, Ellipsis and Substitution, Conjunction and Lexical Cohesion. The analysis of these cohesive elements will reveal how the texts are connected as a whole piece, and the relationships between these variables and the genre of the texts.

Chapter Five deals with the analysis and the discussion of the texts at the group level. This part of the discussion involves the discussion of the nominal groups and the nominalisations in order to see the ideational realisations at the group level, and to examine the consequences which are caused by the nominal groups and nominalisations in the texts, such as lexical density, grammatical metaphor and grammatical intricacy. The analysis of these language features and functions shows what the elements are both at the group and clause level of the language.

Chapter Six will bring a conclusion of the thesis. Besides summarising the findings and analysis of the thesis, it will also point out the limitations and problems of this study and recommend areas for future research.

Chapter 2

A Description of Systemic Functional Grammar and the Literature Review of the Studies in this Area

Introduction

This chapter consists of four parts. The first part is an introduction to Systemic functional grammar, including the comparison of this grammar to other grammars. The second part will provide a brief overview of the application of this grammar in the area of assisting tertiary students' writing in their academic field. The third part regards the significance of why this grammar is chosen for this study. The final part will review the literature in terms of the theoretical underpinnings of this study (Systemic linguistics), and the research carried out in the field of the writing of academic English, particularly that related to the abstracts.

1. Introduction to the Theoretical Framework

1. 1. A Brief Description of Three Different Kinds of Grammar

In the field of language teaching/learning, there are three main kinds of grammar which have played important roles. They are Traditional Grammar, Formal Grammar, and Systemic Functional Grammar.

Traditional Grammar aims at a description of grammar of standard English by using a Latinate grammar. The purpose of teaching Traditional Grammar is to enable language learners to use the correct forms of the language, and to speak "standard and accurate

English". The focus of Traditional Grammar is on the words in isolated sentences. Structure and form are stressed at the expense of meaning and fluency. It seems that learners, using grammatical rules, try to work out the correct forms of the language, though not necessarily the meaning. Traditional Grammar always emphasises convention and rule over meaning, and thus it does not teach students to express themselves.

Typical of this approach is that as described in Traditional Grammar by Jewell A. Friend (Friend, 1974: 1-2). The function of such grammar has been described as "a conscious understanding of the ways in which good sentences are put together" (Friend, 1974). The main concern of Traditional Grammar has been made to tell you what words, groups of words and structures are called, rather than the functions of these words, groups of words and structures.

Formal Grammar was developed primarily by American linguists under the influenced of Noam Chomsky and his theory of Transformational Grammar (Painter,1991: 4-5). As it is claimed by Clare Painter, Formal Grammar regards language as "a syntactic system", an abstract formal system which focuses on a set of rules so as to describe different sentence structures. It emphasises the function of the mind by modelling its capacity to produce an infinite variety of grammatical structures in clauses and sentences. Chomsky argues that the knowledge of the rules of language structure is innate, and the social aspect in the process of learning generally is overlooked. Accordingly, the social implications of learning language are dismissed. Unlike Traditional Grammar, Formal Grammar focuses on what it is possible or impossible for learners to say.

A third kind of grammar is Systemic Functional Grammar (SFG) developed primarily by Professor Michael Halliday. Unlike the other two kinds of grammar, it describes how the language is used, which emphasis the functions of language by viewing language as a "resource for making meaning" (Painter, 1898: 21).

A significant characteristic of Halliday's grammar is that it is meaning-based, which means that the existence of this grammar depends on that of the meaning made by a language user. The difference between Traditional Grammar and the functional grammar is that it views the language as a resource for meaning making. It makes the functions of language so concrete that you can "feel" or "see" how it works. Because it is language users who determine grammar rules, their purposes or intentions in using the language are at the very core of any attempt to understand and describe just what it is that grammar does. A functional model of language as provided by Halliday can provide insights into how language works.

As it is described by the functional model of language, it should be clear that, in Halliday's terms, the starting point for any analysis of language is always a text. It is because language is found to be functional in a text (Halliday & Hasan, 1985: 10) which we might define in simple terms as a "meaningful stretch of language, oral or written" (Derewianka, 1990: 19).

This simple definition indicates the two fundamental characteristics of a text. Firstly, what distinguishes a text from a collection of discrete utterances is its meaningfulness (Halliday & Hasan, 1985: 52). A text can be a projection from a speaker or a written piece from a writer. Its function is to express its language user's intended meaning. For this thesis, the main focus is on written language, therefore, only the written aspects of a text are discussed. Secondly, there is no necessary limit to the length of a text. It can either be long or short. A simple notice, "No Smoking" for example, can be a text in sofar as it creates certain meanings.

What is more important is that this thesis seeks to understand the ways in which these meanings are realised, what has driven a text to create these meanings and how they are expressed in language. To understand these concepts, it is necessary to understand what is behind a text.

1. 2. The Nature of Language

As the theory of systemic linguistics indicates, language is used as a tool for human beings to express themselves. In this process of realising meaning, the general functions which language fulfils can be categorised in the following four ways (Halliday, 1976: 21):

Firstly, language is and has been used to construe the human experience of the world. It is used to interpret the world by organising various phenomena and putting them into different categories. As Professor Halliday says, the are "types of processes, events and actions, class of objects, people and institutions" (Halliday, 1976: 21).

Secondly, language is used to express certain logical relations. Through language, the relationship between phenomena is indicated in terms of time, condition, causality and so on (Halliday, 1976: 21).

Thirdly, language has to show the roles which its users take up and assign. That is to say, it is a resource for enacting social processes (Halliday, 1976: 21).

Lastly, language is made relevant to its context through resources which shape it into a coherent and cohesive text (Halliday, 1976: 21).

The ways of fulfilling these functions are different. As mentioned earlier, they can be either written or spoken. Each carries its own ways to express meaning. What has been indicated by Halliday is that from spoken language to the written language there exists a relatively long process of language learning (Halliday, 1985 B: 9). Both of these points, spoken and written provide the alternatives to express oneself. Both of them follow a certain way for meaning construction.

However, "Written language never was, and never has been, conversation written down" (Halliday, 1985: 41). The language expressed through the written forms is different from

that of the spoken. In literate societies, written language is "highly valued" (Halliday, 1985 B: 41).

The purpose of discussing the difference between the spoken language and written language is to disclose that there must be some language features to determine whether it is spoken or writing language. These language features must have certain tasks to fulfil in a text, therefore, identifying these language features and their functions is significant to the language users, especially those who come from non-English background and study at tertiary level. It is because the area they are dealing with tends to be formal and academic where the written form of a language is mostly used. In order to discover these language features and their functions, it is necessary to realise that there are other factors which influence the language use. They are, as the functional model of language indicates, culture, genre, situation, and register.

1. 2. 1. Language and Culture

No one can talk about the development of language while neglecting to consider its cultural basis. A language and its culture are closely interrelated.

> A social reality (or culture) is itself an edifice of meaning - a semiotic construct. In this perspective, language is one of the semiotic systems that constitute a culture; one that is distinctive in that it also serves as an encoding system for many (though not all) of the others.
>
> ... It means interpreting language with a social culture context, in which the culture itself is interpreted in semiotic terms - as an information system, if that terminology is preferred.
>
> (Halliday,1976: 2).

The suggestion is that there is a context of culture which is a broad and abstract system. It is within this system that the system of a language has evolved.

> It would be nearer the point to say that language actively symbolises the variation that characterises human cultures. This is what enables people to play with variation in language, using it to create meanings of a social kind: to participate in all forms of verbal contest and verbal display, and in the elaborate rhetoric of ordinary daily conversation.
>
> (Halliday,1976: 3).

This is to say that language is the product of a culture, and that language supports the existence of culture. The role language plays in society is therefore central. It is the way that human beings learn how to become participants in their society and how to adapt themselves to their culture (Halliday, 1976: 9). In the process of learning, social contact plays a vital role.

> Knowledge is transmitted in social context, through relationships, those of parent and child, or teacher and pupil, or classmates, that are defined in the value systems and ideology of the culture. And the words that are exchanged in these context get their meaning from activities in which they are embedded, which again are social activities with social agencies and goals.
>
> (Halliday and Hasan, 1985: 5)

Learning a new language is learning new ways of knowing. To acquire this new knowledge, one has to, almost by necessity, become involved in the new environment from which this new knowledge comes.

Where ESL learners are concerned, this culture factor is essential to their learning of the language. The world of English is an entirely new and unfamiliar world to them. The process of adaptation to a new culture, especially in the linguistic field, can be shortened if the means of so doing are made explicit. In the study done by Helen Drury and Carolyn Webb, it is observed that ESL students, if they want to adapt themselves to the new academic environment, have to involve themselves in the new culture.

> Achieving academic literacy is a complex task requiring students not only to master new knowledge and concepts but also to develop appropriate reading and writing strategies to understand and shape the new knowledge and concepts to the forms of enquiry practised a university. 'Becoming literate in the university involves learning to 'read' the culture, learning to come to terms with its distinctive rituals, values, styles of language and behaviour.
>
> (Drury & Webb, 1990).

1. 2. 2. The Notion of Genre

In a culture, people use language for different purposes. The purpose of using language influences the sort of language which will be used.

Jim Martin defines "genre" as "a staged, goal oriented social process" (Martin, 1986: 33). Martin further regards genres as "the way of modelling a higher level of organisation whereby language construes the culture" (Martin, 1986 B: 34).

Language is required to serve different purposes in the interactions among human beings. Distinguishing the purposes of the language amounts to deciding what sort of language is needed and what kind of genre is to be used. In achieving its purpose, a genre will go through predictable stages. Therefore, Martin calls the process a "staged" one. The purpose of using language can be very important, since it has the function of achieving goals for a language user. That is why it is referred to as "goal oriented". In John Gibbons' "Language Focussed and Communication Focussed ESOL Writing", he calls the purpose the "crucial" part of language learning (Gibbons, 1986).

Frances Christie discusses this notion further. She defines the genre as "any staged, purposeful, cultural activity and thus it includes oral language genres as well as written language genres. A genre is characterised by having a schematic structure - a distinctive beginning, middle and end" (Christie, 1984). When talking about the purposes of a language, she comments: "Language serves so many purpose that it is rarely that we can claim that any passage of language satisfies only one purpose" (Christie, 1985: 7). Language is used for various purposes, such as to tell stories, give messages, to argue, to command, or to make statements.

For students, especially the ESL student, the purposes for using the language need to be clarified. Whether they use the language for academic purposes or for other purposes is very important, as language is used to form, maintain or foster their relationships in this new culture.

Rothery, in her study about genre, states that genre actually influences the choices which are made when using the language. These choices involve the three types of meaning that

claimed by Halliday as "co-occuring in the clause: experiential, interpersonal, and textual meaning" (Rothery, 1989: 199-256).

Peter Knapp, in his "A Context For Genre Theory", considers genre as a way to understand language.

> Genres are a way of classifying and understanding the language demands if the different social occasions and the social control exerted through language. So we are not looking at genres as merely structured test types even though many genres can be seen in that way. It is more powerful to understand genre as a form of social control that have developed over time to fulfil prescribed social functions.
>
> Society is structured and controlled effectively through our socialisation in language and it worked more effectively than any police baton or prison wall.
>
> (Knapp, 1989)

Knapp's statements about the relationship between genres and language indicates that genres relate to different categories which fit into different social situations. If genre theory were made explicit to students, especially ESL learners, it would help them to use the language effectively, and enable them to control the environment around them. To master different genres, it is very important for the students to realise how the meanings are created through different stages. Within each stage, there may be its own structure.

In Halliday's theory, the notion of purpose is embedded into the register. Halliday's theory is more register-oriented. The particular register determines the type of the text and what sort of the language is going to be used in the texts.

1. 2. 3. Language and its Context of Situation

As discussed before, the essential characteristic of this theory is that it concerns the choice of language under the influence of culture. Another important characteristic is the functions and uses of language in various contexts of situation. According to Halliday, the relationship between language and context is described as below (See next page):

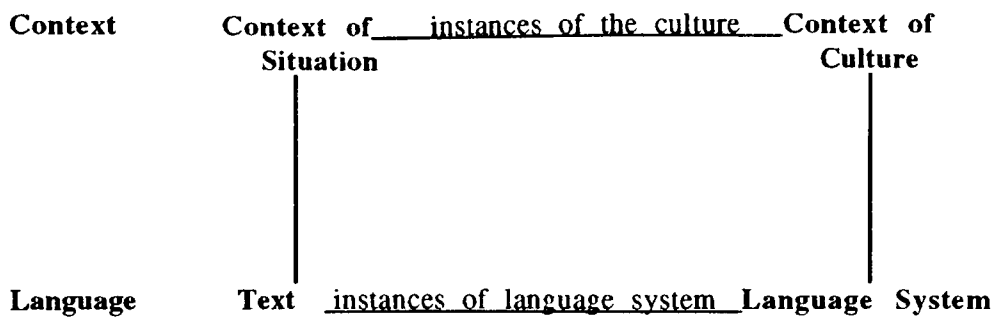


Figure 2. 1: Relationship between language and context (Halliday, 1991)

The diagram above suggests that there is a context of culture which is a broad and abstract system. This cultural system produces the systems of language, which indicates the close relations between these two phenomena. Within the context of culture, there are innumerable contexts of situation which are instances of this system of culture. These contexts of situation engender texts. Text, as Professor Halliday defined, is "any instance of living language that is playing some part in a context of situation" (Halliday &Hasan, 1985: 10). The whole process of producing a text is much more complicated, involving the notion of realisation.

Within a culture, there are various contexts of situation. Language used in daily life is different from that used at school or university. Each context of situation calls for a different type of language. The social context plays as a role of mediator in the process of language learning. "By knowing the variables of the context of situation we can predict how the meanings appropriate to the context could be realised linguistically" (Jones, Gollin, Drury and Economou, 1989: 258-259). In describing the social context, which are relevant should be taken into consideration:

> It is important to qualify the notion of 'situation' by adding the word 'relevant'. The 'context of situation' does not refer to all the bits and pieces of the material environment such as might appear if we had an audio and video recording of a speech event with all the sights and sounds surrounding the utterances. It refers to those features which are relevant to the speech that is taking place.
>
> (Halliday, 1976: 29)

1. 2. 4. The Notion of Register

Those variables of the context of situation which influence the meanings of language and the lexicogrammatical choices to realise the meanings, is referred to as the register. Register concerns the fact that language is used variously when the situations are different. It is the different situations that determine different types of language use or different sorts of "linguistic features" (Halliday, 1976: 32). Register determines the choices from the linguistic system in terms of "what is happening", "who is taking part", and "what part of the language is playing". These three variables are referred to as the Field, Tenor, and Mode respectively.

Field can be thought of as the subject-matter, concerned with the Processes characteristic of the situation, the Participants in those Progresses and the attendant Circumstances.

Tenor reflects the different roles taken up and assigned by interactants in the situation, such as, the speaker and the listener, the writer and the reader. Tenor relationships are concerned with such aspects as status, formality and affect.

Mode refers to the part played by language in the situation. In broad terms, it is concerned with the differences between spoken and written language:

> Two important variables here are the distance between participants in the interaction (e.g., face to face vs. letter writing) and the distance of the speaker or the writer from the events that the language is talking about, that is, language in action versus language as reflection (e.g., TV commentary vs. newspaper reporter).
>
> (Jones, Gollin, Drury and Economou, 1989: 268-269)

In summary, in a particular context of situation, different language choices are made and used according to tenor, field, and mode. These three variables determine the register of a text. They function "to interpret the social context of a text, the environment in which meanings are being exchanged" (Halliday & Hasan, 1985: 12-14).

Halliday and Hasan define field, tenor and mode of discourse as the features of the context. These features in a text are realised by the functional components of the semantic

system (Halliday & Hasan, 1985). All these factors influence language. Through the influence of these factors, language is used to fulfil its function - making meanings. However, to understand how language makes meanings, are need to look at the language systems through which the meanings are realised.

1. 3. The language system

It is through the system of language that meanings are realised. In order to fulfil the function of making meanings, the context of culture has evolved the language system. In this system, the meanings cluster into three "metafunctions" (Halliday, 1985 A: xiii). The Ideational metafunction realises the field which means that it refers to experience and the subject-matter of what is going on. The Interpersonal metafunction realises the tenor which is to say that a text is only ever things that can be done through the agency of people. The Textual metafunction realises the mode, referring to the process whereby language is shaped into text. These semantic metafunctions are realised by choices from the lexicogrammar. The major lexicogrammatical system realising ideational meanings is that of TRANSITIVITY. Transitivity involves the Participants (who or what), the Processes (doings, happenings, etc.), and the Circumstance (when, where, how, why). The system realising interpersonal meanings is MOOD, concerned with speech function options. And the systems realising textual meanings are that of Theme at the clause level, which deals with how infomation is structured, and that of COHESION at the discourse level, represented by the pattern of referencing conjunction, the use of lexical cohesion, ellipsis and substitution. All these grammatical features are realised by phonology or graphology which are soundings or graphic symbols of the language.

A text is the product of the contributions of all the metafunctional elements, ideational, interpersonal, and textual. Through analysis of text, the language features in a text can be identified and the meanings of a text can be made explicit. When a text is analysed, systemic functional grammar provides tools to ascertain whether the text makes the meaning clear, and whether the language structure of the text is appropriate or not. In

order to know how this language system works, the following is to introduce the principles of this grammar.

In SFG, language is labelled in two ways, they are, class labelling and function labelling. Class labelling indicates in a general way, the grammatical potential of linguistic items, such as "verbness" and "nonces" (Halliday , 1985 A: 28).

Example:

She	is putting	the letter	in the mailbox.
nominal group	Verbal group	nominal group	Prep. phrase

Since the text analysis in this thesis does not include the analysis of class labelling, detailed information will not be provided.

The other way of labelling is in respect to function. Function labelling helps readers to know what functions the various components are performing in a clause (Halliday, 1985 A: 31).

Example:

She	is putting	the letter	in the mailbox.
Participant:	Process:	Participant:	Circumstance:
Actor	Material	Goal	Location

Functional labelling is different from Class labelling as it makes grammar interpretative rather than descriptive.To analyse the structure of the language using functional categories is to analyse of the meaning of a text. In the introduction to this grammar system, it only covers those areas which are going to be dealt in the later text analysis.

Transitivity

The transitivity system deals with the world of experience: the experiential aspect of the ideational metafunction. The experience of the world is concerned with things, with goings on and the circumstances. In SFG, these three aspects are called Participants, Processes, and Circumstances. In the field of traditional grammar, they are interpreted as verbs, nouns, and "the rest". In a SFG interpretation of Transitivity, the Processes are typically realised by verbal groups. The Participants (Subjects and Objects in Traditional

Grammar) are realised by nominal groups. The Circumstances are realised by adverbial groups and prepositional phrases.

The Traditional Grammar category of "verb" gives an impression of "doing things only". When you think of most stretches of language, there are other elements that need to be considered, such as they are "sensing" and "sayings". The expression--"verbs" in Traditional Grammar, is not accurate enough for what is going on in a real event. In SFG, there are different types of Processes. They are "doing processes" which are referred to as "Material" and the "Behavioural"; "meaning processes" which are referred to as "Mental" and the "Verbal"; and "being processes" which are referred to as "Relational" and "Existential". Each Participant takes up different roles according to the kind of Process. The collocation is as follows:

	PARTICIPANT	PROCESS	PARTICPANT
Doing	Actor Behaver	Material Behavioural	Goal/Range Range
Meaning	Senser Sayer	Mental Verbal	Phenomenon Verbiage
Being	Identified Carrier Existent	Identifying Attributive Existential	Identifier Attribute

Table 2. 1: The Collocation of Participants and Processes

Examples of Doing Processes:

(Material)

Many Chinese Students	are doing	PHd	at The University of Wollongong.
Participant	Process	Participant	Circumstance
Actor	Material	Range	Location

(Behavioural)

She	cried.
Participant	Process
Behaver	Behavioural

Example of Meaning Processes:

(Mental Process)

She	thought	he would not come.
Participant	Process	Participant
Senser	Mental	Phenomenon

(Verbal Process)

I	did not say	anything.
Participant	Process	Participant
Sayer	Verbal	Verbiage

Example of Being Processes:

(Identifying)

His name	is	Tim.
Participant	Process	Participant
Value	Relational	Token
Identified	Identifying	Identifier

(Attributive)

He	is	eight years old.
Participant	Process	Participant
Carrier	Attributive	Attribute

(Existential)

There is	a book.
Process	Participant
Existential	Existent

The principle types of circumstantial element are: time, location, manner, means, cause, accompaniment, matter, and role.

Theme and Rheme

In constructing a clause, it is always a question of what organisation gives the clause its character as a message. That is, we need to choose a point of departure. This kind of structure is defined as "thematic" structure (Halliday, 1985 A: 38). In English, Theme is indicated by initial position in a clause. Theme comes first followed by Rheme.

Example:

She	is expecting a letter from you.
Theme	Rheme

Theme in a clause is a starting point. It tells listeners or readers how the speaker/writer is developing the text. Theme can be a nominal group, an adverbial group or a prepositional

phrase. The analysis of Theme-Rheme structure can provide an insight into the flow of the text and the underlying concerns of its author.

Cohesion

Cohesion is also a part of the language system. It is defined as:

> The concept of cohesion is semantic one; it refers to relations of meaning that exist within the text, and that define it as a text. Cohesion occurs where the INTERPRETATION of some element in the discourse is dependent on that of another.
>
> (Halliday & Hasan, 1976: 4)

Another significant language feature is the cohesion in text. One characteristic of a text is that it is different from a collection of unrelated sentences, because a text, either spoken or written is a unified whole.

> A text is best regarded as a SEMANTIC unit: a unit not of form but of meaning. Thus it is related to a clause or sentence not by size but by REALISATION, the coding of one symbolic system in another. A text does not CONSIST OF sentences; it is REALISED BY, or encoded in, sentences. If we understand it in this way, we shall not expect to find the same kind of STRUCTURAL integration among the parts of a text as we find among the parts of a sentence or clause. The unity of a text is a unity of a different kind.
>
> (Halliday & Hasan, 1976: 2).

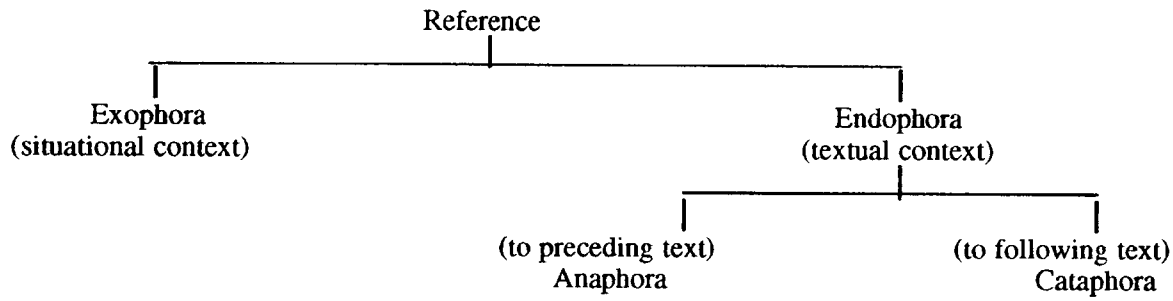
In Halliday and Hasan's "Cohesion in English", they stated that cohesion "refers to relations of meaning that exist within a text, and that define it as a text" (Halliday & Hasan, 1976: 4). Cohesion is the "relationships in which the interpretation of one idea (we may call it 'new') in the text depends on successful interpretation of another (we may call it 'old') " (Irwin, 1980: 3). The term "cohesion in text" was introduced by Halliday "explicitly for the purpose of linguistic analysis" (Clark, 1977). The links in text that are set up by cohesion are called "cohesive ties". In Understanding and Teaching Cohesion Comprehension (Irwin, 1980), Irwin has mentioned that the cohesive tie is a "device" that "often used in texts as it is one of the basic ways of relating one part of a sentence with another and, what is just as important in this context, linking sentence." When analysing a text, the cohesive ties can be examined in order to comment on whether this text is

comprehensible. One of the important research findings is that "text cohesion is related to comprehension" (Irwin, 1980: 38-39).

It is significant to see how the cohesive items act in a text and how the cohesive relationships are established. According to Halliday and Hasan, the cohesive items are categorised into the following groups: Reference, Substitution, Ellipsis, Conjunction and Lexical Cohesion (Halliday & Hasan, 1976). The characteristics of the Reference group are as follows:

> What characterises this particular type of cohesion, that which we are calling REFERENCE, is the specific nature of the information that is signalled for retrieval. In the case of reference the information to be retrieved is the referential meaning, the identity of the particular thing or class of things that is being referred to; and the cohesion lies in the continuity of reference, whereby the same thing enters into the discourse a second time.
>
> (Halliday & Hasan, 1976: 31)

As it is stated by Halliday and Hasan (1976), the reference group can be divided as follows (See next page):



(Halliday & Hasan, 1976: 33)

Figure 2. 2: The reference system

As the diagram shows, the reference group includes both exophora and endophora. The exophora relates to the factors outside the text while the endophora refers to factors within the text. The endophoric reference can be divided further into anaphora and cataphora. In the reference group, there are three types of cohesive ties, which are personal, demonstrative and comparative. These three kinds of reference have different functions in a text:

Personal reference is reference by means of function in the speech situation, through the category of PERSON.
Demonstrative reference is reference by means of location, on a scale of PROXIMITY.
Comparative reference is indirect reference by means of IDENTITY or SIMILARITY.

(Halliday and Hasan, 1976: 37).

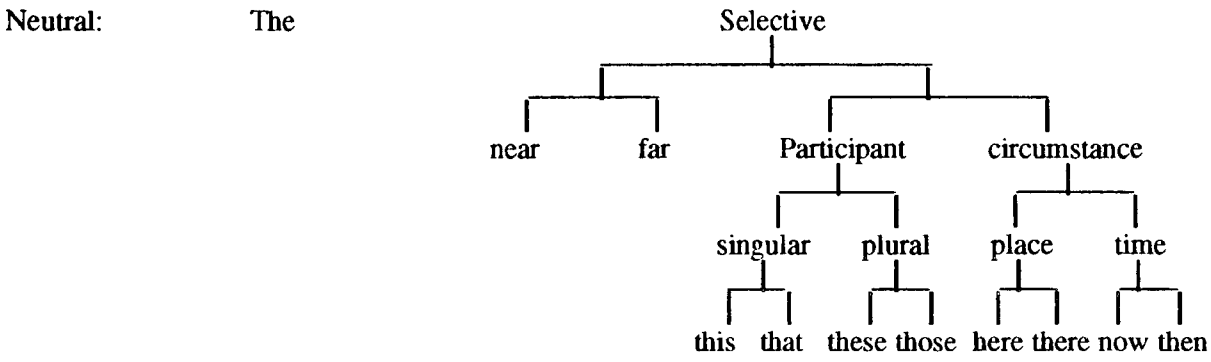
Personal reference contains personal pronouns, possessive adjective and possessive pronouns (See the table below). This system enables the reader or listener to identify the speaker and the relation between the speaker and the person being referred in the conversation and what sort of roles they play (Chapman, 1983: 57).

Personal Pronouns	I me	we us	you	they them	he him	she her	it	one
Possessive Adjectives	mine	ours	yours	theirs	his	her	its	
Possessive Pronouns	my	our	your	their	his	her	its	one's
Functions in Speech Plural form	Speaker and Addressee Usually Humans			Specific Person(s) human specific			Non-	Non-

Table 2. 2: The system of Personal reference

Most forms of personal reference are commonly used in a speech situation, therefore they rarely appear in academic written text.

Demonstrative reference is defined as "a form of verbal pointing" (Halliday & Hasan, 1975: 57) which illustrates cohesive ties in a text. To identify, for example, the location near or far, different pronouns are used in a spoken or a written text. The following diagram is a summary of demonstrative reference and their functions in a text.



(Halliday and Hasan, 1976: 57)

Figure 2. 3: The system of Demonstrative Reference

Using demonstrative reference can provide information which indicates the numbers of the participants, when and where a certain event happens. However, demonstrative reference is still exphoric reference which relies on the contextual or situational conditions.

Comparative reference indicates the similarities and differences between two or more things in terms of appearance, quality and quantity. It is divided into two groups: general and particular. General comparison refers to the "likeness" and "unlikeness" while particular comparison refers to the "quantity" and "quality" (Halliday & Hasan, 1976: 77).

The second group in the cohesion system is the substitutions. Substitutions, in Halliday and Hasan's book, are defined as "a relation in the wording rather than in the meaning" (Halliday & Hasan, 1976: 88). There are three kinds of substitutions. They are Nominal, Verbal and Clausal. In nominal substitution, the words are: one, ones, and same. Verbal substitution consists of "do". Clausal substitution consists of "so" and "that".

The third group is ellipsis. In a sense, ellipsis is similar to the substitution group. Ellipsis can be defined as "something left unsaid" (Halliday and Hasan, 1976: 142).

> When we talk of ellipsis, we are not referring to any and every instance in which there is some information that the speaker has to supply from his own evidence. That would apply to practically every sentence that is ever spoken or written, and would be of no help in explaining the nature of a text. We are referring specially to sentences, clauses,etc whose structure is such as to presuppose some preceding item, which then serves as the source of the missing information. An elliptical item is one which, as it were, leaves specific structural slots to be filled from elsewhere.
>
> (Halliday and Hasan, 1976:143)
>
> There is no implication here that what is unsaid is not understood: on the contrary, 'unsaid' implies 'but understood nevertheless', and another way of referring to ellipsis is in fact as SOMETHING UNDERSTOOD, where understood is used in the special sense of 'going without saying'(compare *it is understood that we are to be consulted before any agreement is reach*).
>
> (Halliday and Hasan, 1976:142).

In a sense, ellipsis refers to words which are "recoverable" (Quirk, 1972. Cited Chapman, 1983). This indicates that these words can be omitted in a sentence without influence on the meaning of the sentence. One purpose of using ellipsis is to avoid the

repetition. To a certain extent, ellipsis is like substitution. When writing, an author may like the reader to make the reference back in order to avoid the repetition in this writing. It is a important to know how to use ellipsis appropriately and how to omit the right words at the right place and time without leaving any gap which the reader can not fill. There are Nominal ellipsis, Verbal ellipsis and Clausal ellipsis.

The fourth group is the conjunction group. Different from other cohesive elements, conjunctions have specific meanings and fulfil the function of not only connecting but also confirming the related elements in a text (Chapman, 1983: 87). As it is stated in Halliday and Hasan's book:

> With conjunction, on the other hand, we move into a different instruction, but a specification of the way in which what is to follow is systematically connected to what has gone before.
>
> (Halliday & Hasan, 1976: 227)

In other words, conjunctions are used to expressed the logical relations in a text. There are different types of conjunctive relations. These relations "constitute a highly generalised component within the semantic system, with reflexes spread throughout the language, taking various forms; and their cohesive potential derives from this source" (Halliday & Hasan, 1976: 227). According to Halliday and Hasan, four types of conjunctions are provided. They are the additive which is also called the 'and' type; the adversative or the 'yet' type; the temporal or the 'then' type; and the causal or 'so' type. These conjunction are the signals which illustrate different relations among sentences and different types of meanings projected by the author.

The final group is the lexical cohesion group. If reference, substitutions and ellipsis are functioning in grammar, then lexical cohesion functions in vocabulary and the selections which a language user chooses (Halliday & Hasan, 1976: 275). Lexical cohesion deals with the meaning of words and their relationships. The main relationships are synonymy, antonymy, hyponymy, repetition and collocation.

The above is an introduction to those aspects of the language system and its principles which will be covered in the later text analysis. The following section will examine how such analytical tools have been used in research studies.

2. Studies in the systemic linguistic field

While the theory of SFG is constantly developing, it has been applied in the practical teaching and learning for various purposes and as a framework for research. Here a few studies employing SFG in teaching and research at the teaching level will be reviewed.

2. 1. A Brief Overview of the Application of SFG in Assisting Overseas Students at Tertiary Level in their Academic Writing

Historically, this grammar has already been implemented in assisting student's writing at tertiary level for some time. Although there is not currently a thorough-on going evaluation of its efficiency, many studies have been carried out to show how systemic functional grammar has proved useful in its interpretation of the elements of linguist structures. Halliday mentions in his book Introduction To Functional Grammar, "...each element in a language is explained by reference to its functions in the total linguistic system...." therefore, a functional grammar is one that constructs all the units of a language--its clauses, phrases and so on--as organic configurations of functions" (Halliday, 1985: xiii-xiv). This means that SFG looks at the language of a text semantically. Each component is intrinsically linked to other components. Unlike Traditional Grammar, SFG does not interpret language as forms in an isolated, decontextualised fashion.

On the basis of a pilot study for this thesis study, it can be said that this grammar can play a very important role in helping second language learners to use the language effectively. According to this grammar, language is seen as a whole complex of choices about meaning making. Some universities are already using SFG to help students with their written English.

At the University of Sydney, overseas students have been offered tuition in language since 1976. The staff of the Learning Assistance Centre help students of the university to acquire the skills necessary for the exchange and communication of ideas and knowledge. In order to help the students to develop their language skills, Systemic Functional Grammar has been the focus of the teaching at the centre. From the results of a previous survey of such programs done by the present author, it can be seen that all the teachers are committed followers of functional grammar. They feel that the functional grammar is more useful than Traditional Grammar, especially in the organisation of essay writing, and that it can be an alternative to Traditional Grammar. In terms of the most useful aspects of the grammatical features of SFG, it is thought that Martin's genre theory or schematic structure are the outstanding ones. These two aspects have made the ways of writing so explicit that the students can analyse their own texts and identify the problems by themselves. The response from the students is that this grammar is acting as a tool which they can use to find their problems in using the language and "fix" the problems. The improvement of the students' work has shown that functional grammar has helped greatly in the student essay writing.

At the Institute of Language, in The University of New South Wales, the application of SFG in assisting overseas students' essay writing has been carried on for more than five years. The purpose of this program is to enable students to master the knowledge of textual analysis with regard to coherence of both the lexical and semantic structures. In the textbook used by the teachers there, the focus of their teaching is to let the students know how to use the language to serve their own writing purpose (See Appendix II).

In their teaching of SFG, the language is viewed at both clause and text levels. The former is to help the students identify the ways in which the meanings are created, the latter is to show how a text is structured so as to achieve its purpose. With these skills, the students can work out the purpose of using the language within their context of culture and context of situation, and how the meaning is made based on their different choices.

From the students' perspective, they grasp this grammar very quickly, since they know what they are doing, and what purpose they are going to achieve (See Appendix II).

From this brief overview of the application of Systemic Functional Grammar, the conclusion can be drawn that SFG is sufficient and valuable in assisting overseas student's written work by revealing the language features, and it can be regarded as an alternative to Traditional grammar.

2. 2. Other Relevant Studies and their Research Findings of this Area

As the research findings show, writing academic English requires a language user to use certain types of language. This language, as it is determined by its genres and register, shows its features as academic. Although there are not enough studies about the effective ways of writing an abstract as mentioned in the previous part of the thesis (Chapter 1), nevertheless, many studies can share a lot of similarities.

Systemic functional grammar can make the language expectations of the university explicit by describing and analysing it. This analysis also has the potential to make new ways of making meanings that are important to success. Through the analysis of the grammatical elements in the language, the style of the language which is required for different contexts is exposed. So to speak, if the students want to master academic literacy, it is necessary to make the ways of writing more explicit.

Helen Drury, in her study on the application of systemic functional grammar to the analysis of students' texts, has found differences and similarities among the students with both ESL backgrounds and native backgrounds. Through the identification of the language features of the texts, the way to write academic English can be made explicit (Drury, 1989). Students need the language for their academic purposes. However, quite often they have not been appropriately advised. In Drury's work, she has provided some effective guidance to those students, especially the non-English speaking students. The

analyses of students' written work have shown the problems in these written texts. In the process of the analysis, SFG was the theoretical framework.

Drury has analysed the students' texts in terms of Theme and Rheme, Transitivity and grammatical metaphor. In the analysis of Theme, the ESL students tended to use Thematic choices which sound very personal in their academic written work, which is inappropriate. They tried to have more human Themes, namely the human elements. That is to say that the ESL students' texts are projecting-oriented. They wrote from their own points of view. In the analysis of Transitivity of the texts, the ESL students tended to use more active forms while in the analysis of lexical density, the students found difficulty in writing texts in which the lexical items were condensed, metaphorical, and abstract.

In Drury's study, she pointed out that the weakness of the ESL learners are exacerbated by an incomplete understanding of the genre or the purpose of writing and the ability to use the lexicogrammar to make appropriate meanings. She also pointed out the ways of constructing an academic text. According to Drury's study, it is said that academic texts are very abstract. There is a great distance between the writer and the reader. The field of the language which is used to construct a text is a technical world. The tenor of the academic context should be very impersonal.

What can be understood from Drury's study is the significance of making the language features and genres in academic writing clear and explicit. The language features are described as the abstractions, impersonality, and the condensation of the lexical items. In order to write academically, these factors that influence the language, the culture, the context and the purpose need to be made explicit. With the results from Drury's study, it can be seen that what has been an empty page in the area of abstract writing is the explicitness of the language features and their functions.

In another study done by Helen Drury and Carolyn Webb, they have found that the reason why the ESL students have difficulties in English is that these students can not use

the language appropriately in the academic field in university. To become academically literate, it requires these students to master new knowledge and to know the new culture. A way to help these students become literate in the academic field is through systemic functional grammar, since this grammar "offers a semantically based framework for describing the choices made in the lexicogrammar in terms of their functions and purpose within a given situation and culture" (Drury & Webb, 1990).

Further discussions on the features of academic writing relate to Martin's genre studies. To make the ways of writing explicit, another way to look at a text is in terms of genre - "a staged goal oriented social process" (Martin, 1986 B). It is necessary to learn different genres since each genre can determine what sort of language should be used in order to serve a certain purpose. Frances Christie, also emphasises the important roles which different genres play in writing. "Learning the genres of one's culture is part of learning to become a successful participant in the culture" (Christie, 1987: 10).

As the Martin's model of language shows, the cultural context has produced various genres. These genres, then, are used in various fields to express the culture. Without the knowledge of different genres, it is hard to accomplish the writing tasks set at universities. Certain relevant genres have been identified by Martin and others, such as "Procedure" (how to do things), "Description" (what some particular things look like), "Report" (the descriptions of a whole class of things), "Explanation" (why or how a phenomenon is as it is), and "Exposition" (arguing for the thesis that has been established in the writing) (Martin, 1985: 2-5).

It is in Rothery's work that different genres of report and expositions are explained further and explicitly. According to Rothery, the Report and Exposition are distinguished by their different goals. and to achieve the different goals, the structure is also different. The goal in exposition is to persuade the reader of the truth of "rightness" of a proposition while the goal of a report is the description of how things are. The structure of Exposition is as follows: Thesis^Arguement^Conclusion. The structure of a Report is General

Classification^Description (Joan Rothery, 1985). These stages in a text consist of a "beginning-middle-end structure" (Hasan, 1985 & Jones, Gollin, Drury and Economou, 1989).

In the academic area of writing at tertiary level, the most common type of writing is expository writing. It is because most of the writing tasks are dealing with the interpretation of our experience of reality. Besides these, the critical and analytical comments on the reality have to be made so as to challenge the reality. Learning different genres is know how to achieve the purposes required by the writing tasks.

As these different genres in factual writing are described in detail, more specific discussions and descriptions are given. The different sorts of expository writing have been examined. In writing expository essays, the thesis is the essential part. According to Martin's theory, on the basis of the different tasks of the thesis, there are two kinds of writing in exposition. They are "analytical" and "hortatory". The difference between these two kinds of writing is that "persuades to" is "Hortatory" and "persuades that" refers to "Analytical".

Hortatory Exposition is commonly found in editorials, letters to the editor, sermons, political speeches and debates, office memos about employees' behaviour, and so on. Analytical Exposition is more typical of lectures, seminars, tutorials, scholarly papers, essay writing, and examination answer. In general, in our culture Hortatary texts are wither spoken, or if written, exhibit a number of the characteristics of spoken English. Analytical texts, on the other hand, tend to be written, and if spoken, to share many of the features of written language.

(Martin, 1985: 17)

What can be summarised from the above is that the characteristics of the language in exposition writing are "highly metaphorical, impersonal, and has a tendency to reason within rather than between clauses" (Martin, 1985: 25). Expository tries to give an interpretation of the world. Simple description of the phenomena is not effective enough to persuade other people to believe what has been discussed. One effective way is to use metaphor, which can convince the reader to agree with the writer. Among the metaphorical explanations, "personification" is the one that is frequently used. When a

thing is personified, it becomes the "Actor" (Halliday, 1985 A) in this "event" so as to get rid of human as the "Actor".

Impersonality is another characteristic. A sense of rationality is important in expository writing. Reason and personal emotion are not harmonious in such writing. This point is stated in Martin's work as "Intellect must not be confused with feeling, and whenever it is we become suspicious" (Martin, 1985: 25). The ways to express personal feelings and emotions are very restricted. In scientific writing, the passive is usually used to remove the human in a clause, which is called hiding the "Agent" (Halliday, 1985 A: 154).

The third characteristic of expository writing is reasoning. Effective reasoning requires effective deployment of grammatical resources. In Martin's work, four ways of reasoning are mentioned. They are through conjunctions, prepositions or prepositional phrases, verbs, and nouns. They are grammatical elements which serve to fulfil the task of reasoning in the language (Martin, 1985: 19).

The detailed genre description alluded to above examines the language from two perspectives: from the text level and clause level, or macro-level and micro-level. From the text level, it is believed that each text follows the pattern as "Beginning-Middle-End". These constitute the different stages in the process of realising the purpose of a text. From the clause level, what is pointed out is the way in which genre and register work together. As discussed previously, the different genres determine the language features, such as the types of Participants or patterns of Themes.

Although abstract writing is not included in the descriptions above (Hasan, 1985, Martin & Rothery, 1985 & Jones, Gollin, Drury & Economou, 1989), the linguistic insights can be applied to the analysis of the abstracts, because each abstract is a piece of written text.

In addition to the schematic structure, it is necessary to consider the ideational content of the text. This requires further detailed discussion of the language features in academic

writing at the micro-level. Wignell, Martin and Eggins have discussed the language features in academic areas, such as the area of the sciences.

From their studies, the typical language features and functions they play in the texts of geography and history are described in great detail. Geography is a natural science which observes, orders and explains what is happening in the natural world. As the studies show, the purpose is to study the usage of the linguistic resources which have been used to achieve such tasks as "developing a model of a technical/science field".

Geography belongs to the natural sciences. However, it is quite different from other subjects like mathematics, chemistry, physics and so on. It is quite implicit. A lot of language features are used in the field of geography. This subject possesses the functions of language in classifying and explaining which involve a shift from the common sense of the everyday use of language.

> The mover from describing to classifying is a move from the every day to the technical; and the move from classifying to explaining is a move from talking about things to talking about processes.
>
> (Wignell, Martin & Eggins, 1985: 26).

The achievement of the goals, such as "describing" and "explaining" the phenomenon in the world is realised by establishing a "technical lexis" so as to "order" the world through the arrangement of the technical terms into "taxonomies". The explanations if the world come through the "implication sequences of cause and effect".

In terms of the field of geography, it consists of "the inter-related taxonomies and sets of implication sequences". All these taxonomies are elaborated in geography text books in order to show how things come out.

As far as the linguistics is concerned, geography is "about the inter-relationships between terms in taxonomies"(Wignell, Martin & Eggins, 1985: 62). However, these taxonomies are not indicated explicitly, such as a formula. They are expressed by the lexico-grammar. When learning geography, the students not only get to know "order and meaning in the

experiential world", but to discover the implications of "order and meaning" in discourse of geography.

In the discourse analysis of geography, the implication shows that it is the shift from everyday language to a technical terms. It does influence the quality of student's writing in the academic field. An engineering student, for example, intending to describe what has been observed and studied in an experiment, has to use the special terms in the field in order to show his/her expertise. The significance of doing this is to distinguish this student from others who are not familiar with this field and fail to make the writing more scientific and technical. The ways in which things and phenomena are technicalised are naming and making the name technical. In the linguistic field, these are realised by nominal group constituents, usually Things or Classifier^Thing compounds (Halliday, 1985 A: 159-174). In their study, the ways of technicality are introduced as follows:

a). A technical term may be a single nominal or Thing.
b). A technical term may consist of a nominal group compound, with a Classifier^Thing structure.
c). Technical nominal groups compounds of the Classifier^Thing type may also be derived from what we will be calling "implication sequences".
d). A technical term may also be derived through nominalisation.
e). An extension of this is to have a technical nominal group compound with a Classifier^Thing structure, but where the Classifier is a nominalisation representing the Agent from an implication sequence.
f). Technical verbs always have a corresponding nominalised form so that they can be treated as Things in the text.

(Wignell, Martin and Eggins, 1987: 37-38).

It is the grammatical metaphor that distances what people actually have done and what is written down. It has become a typical feature in the written language and it has brought a notion of "abstraction" and "distance" in the written language. In English culture, a high degree of grammatical metaphor text is regarded as "prestigious".

Both these language features - technicality and metaphor - have become important linguistic elements in the writing of science and technology. The significance of these study findings are the keys to the analysis of the abstracts in this study.

Using the methods used in the analysis of geography and history, it is interesting to find out the linguistic features in the abstracts analysed in this study and what kinds of functions they have in these specific written texts.

V. Conclusion

In this chapter, the author has briefly outlined the aspects of SFG which are relevant to the present study. The brief overview of the application of System Functional Grammar at the tertiary level to both teaching and research, provides insights into how SFG might be used to get a clear view of abstract writing. The system of the grammar provides ways to analyse these abstracts in terms of the purpose, forms of the language and their functions.

As the studies show, what have been exposed are the linguistic features and their functions in academic English or English for Science and Technology. However, not many studies deal with the abstract writing. Although in Swale's "Genre Study", certain features of abstracts are discussed, it neglects the functions of the language in abstracts. Whether an abstract has a "distinct" schematic structure of it own, or whether its language features and functions are similar to other types of academic writing remain unresolved. What is intended to do in this study is to explore all those untouched areas with the support of other people's theories and research findings.

Chapter 3

Description of Methodology

The previous chapter provided a detailed discussion of the theoretical framework of this study and a review of studies and findings in the area of applying SFG in assisting overseas students' written English. In this chapter, the main focus is on the description of the methodology used in this study.

1. Levels of Analysis

In realising the aim of this thesis, both qualitative and quantitative research methods have been used.

All the abstracts are analysed at the different levels. They are macro-level or text level, micro-level or the clause level and the group level which goes below the clause level. The analysis at the text level provides an overview of the abstracts in terms of the schematic structure and the logical connections which link up the whole texts. Following the text level, the abstracts will be analysed at the clause level. The clause can be seen as the "gateway" to the grammar (Butt, 1990). This is the level at which language users construct a picture of experience, set up speech roles for themselves and the listeners and structure their message so that it relates to the context. Further and more detailed analysis will be carried out at the group level. At this level, what will be identified are more detailed language features and functions below the clauses and texts in the abstracts.

2. The Analytic Framework

As stated in Chapter 2, the theoretical framework of this study is functional grammar. This section will explain why this grammar has been used for this study.

The notion most fundamental to Systemic Functional Grammar is that language consists of systems of choices as to the meaning made (Halliday, 1985). As for the term "functional", Professor Michael Halliday, states that his grammar is functional in three senses: in "its interpretation (1) of texts, (2) of the system, and (3) of the elements of linguistic structure" (Halliday, 1985 A: 3).

Firstly, it is functional "in its interpretation of texts." According to Halliday and Hasan, text is defined as language which is functional in a particular context. It is not an incoherent and disunified assembly of sentences or words combined together randomly. Every text has its own specific purpose, eg. to demand, to argue, or to make a statement. Language has been used by human beings in order to serve their purposes, and, naturally the way the language is organised reflects this functional orientation. In language, every element can be explained in terms of the functions language has evolved to perform.

Secondly, SFG is functional in the interpretation of the language system. In this system, every component involved in the language is regarded as functional. In his Introduction to Functional Grammar, Halliday argues that: "All languages are organised around two main kinds of meaning, the 'ideational' or reflective, and the 'interpersonal' or active. These components, called 'metafunctions' in the terminology of the present theory, are the manifestations in the linguistic system of the two very general purposes which underlie all uses of language: (i) to understand the environment (ideational), and (ii) to act on others in it (interpersonal). Combined with these is a third metafunctional component, the 'textual', which breathes relevance into the other two" (Halliday, 1985 A: xiii).

Any text can be examined from these three perspectives. SFG can analyse each clause in a text from the point of view of its meaning as: an interpretation of experience, which is

ideational, a contribution to human interaction, which is called interpersonal, and a message structure, which is textual. These three points of view of a text can build a very rich interpretation of any text. But it is the correlation between register variables and metafunctions that plays an important role in developing a powerful model of text in context. The choice of field controls the pattern of ideational meanings; the choice of tenor decides the interpersonal meaning; and the choice of mode determines the textual meaning in any text.

Thirdly, SFG is functional in its interpretation of the elements of linguistic structures. Halliday observes in his book Introduction To Functional Grammar (1985 A), " each element in a language is explained by reference to its functions in the total linguistic system. "In this third sense, therefore, a functional grammar is one that constructs all the units of a language -its clauses, phrases and so on- as organic configurations of functions." That means that SFG looks at the language in a text semantically. Each component is linked up with the other. Unlike formal grammar, SFG does not interpret language solely in terms of grammatical class and structures.

According to Halliday, SFG is used for many purposes, one of which is the analysis of texts. "The aim has been to construct a grammar for purposes of text analysis: one that would make it possible to say sensible and useful things about any text, spoken or written, in modern English" (Halliday, 1985 A).

In analysis of a text, one can aim at two possible levels of achievement. One is "a contribution of the understanding of the text", the other is "a contribution of the evaluation" (Halliday, 1985 A: 15)

Relating to the contribution of understanding, it is said that the linguistic analysis can indicate the author's writing process, i.e. how he/she builds up his/her ideas in the text, and the author's intention of writing this text. By doing the analysis, different meanings, choices, ambiguities, metaphors of the text can be "revealed". Quite often it is not the

student's competence in the language that makes the writing sound awkward. It is likely to be their way of developing their ideas and their intentions that have influenced their written work.

The other contribution is "evaluation of the text". It is not enough to understand the author's writing process and his/her intention. If we comment on a text, we often take into consideration the effectiveness of the text. Linguistic analysis may help judge a text. In Halliday's Introduction to Functional Grammar (1985 A), he stated: "This is very hard to attain. It assumes an interpretation not only of the environment of the text, its 'context of situation' and 'context of culture', but also how the linguistic features of a text relate systematically to the features of its environment, including the intention of those involved in its production" (Halliday, 1985 B).

To analyse a text is to help comment on the quality of the text. Several factors should be accounted for in the interpretation of it. They are the "environment of the text" - the "context of situation" and "context of culture". The more important is whether all the linguistic features of a text are systematically consistent with the features of the text environment. Thus it is possible to indicate the relationship between the meaning of a text and the grammatical structure.

In terms of the relation between the meaning of a text and the grammar, Halliday said in his Introduction to Functional Grammar, "A text is a semantic unit, not a grammatical one. But meanings are realised through wordings, and without a theory of wording - that is, a grammar- there is no way of making explicit one's interpretation of these meaning of a text. Thus the present interest in discourse analysis is in fact providing a context within which grammar has a central place."(Halliday, 1985 A: 17). In order to understand what a text means, then, we need to look at the grammar.

3. Description of the Data

3. 1. A brief introduction to the texts analysed

An analysis of the linguistic features and their functions in the writing of abstracts will be carried out with a set of three texts. The texts were written by Chinese students who were studying for a doctorate in the field of engineering at the University of Wollongong (See Appendix III). These texts deal with the field of English for Science and Technology, in particular, the engineering field.

For the sake of clarity and convenience, each text will be referred to, respectively, as "Text I", "Text II" and "Text III" instead of mentioning the names of the students. Following is a brief description of each text.

Text I Title: Comprehensive Tool Wear Estimation in Finish-Machining via Multivariate Time-Service Analysis of 3-D Cutting Forces

Text I deals with mechanical engineering. It was published in a journal (Annals of the CIRP Vol. 39/1/1990).

Text II Title: A Flow Control Strategy for the Transmission of Variable Bit Rate Speech on Lan's

Text II is concerned with electronic engineering in the area of tele-communication. This paper was also published at a conference (Australian Fast Packet Switching Workshop, Melbourne, 9-11 July 1990).

Text III Title: Instant-Chilled Steel Slag Aggregate in Concrete-Strength Related Properties

Text III is about material engineering. It was published in an international journal which is named "CEMENT and CONCRETE RESEARCH" (Vol. 21, No. 6. Nov. 1991).

From the above, it can be seen that the purpose of the abstracts is for publication in a journal or presentation for a conference. Therefore, they may be characterised by some special linguistic characteristics so as to meet a range of requirements from the publishers or conference organisers. However, this will be discussed in Chapter 4.

3. 2. The Procedure

The procedure of the study was as follows. In 1991, a case study was carried out. The main purpose of that study was to identify the problems in the overseas students' written English. These students were involved in that case study. During the study, the researcher conducted several interviews with these students. Some written texts were collected from these students. The topics of their texts were the papers for different conferences in their own field. The texts were written under the guidance of their supervisors. The students wrote the first drafts and revised them. Then their supervisors read the papers. Later, they revised them a second time or third time. The second or the third drafts were read by their supervisors until the final drafts were subsequently approved.

3. 3. The Students

The students who have written these texts are all from non-English-speaking backgrounds. Before they started doing their Ph D studies at The University of Wollongong, their degree of exposure to English was quite high. The first student passed the entrance exam for overseas students at the University of Wollongong. The second student got an excellent result in her IELTS (International English Language Test System). The third student passed the EPT (English Proficiency Test), which is an official English test held in China for visiting scholars abroad and recognised internationally. They are now conducting research and lecturing in their fields in different universities.

3. 4. The Field - Science and Technology

The field of the texts, as mentioned above, deals with science and technology. The reasons why this field has been chosen are: firstly, not many studies have been done in the area of writing abstracts in the discourse of science and technology; secondly, most overseas students at the University of Wollongong, especially the students from China and other Asian countries, are undertaking studies in the field of science and engineering. Writing in the field of science and technology is obviously crucial to them, since this is the main task in their studies.

4. Methods of the Text Analysis

In the text analysis, the texts will be analysed at the text level or macro-level, and clause and group level or micro-level. The text analysis will cover two aspects: textual and ideational. In the former analysis, these texts will be analysed in the area of schematic structure, Theme and Rheme and cohesion while the latter analysis will cover Transitivity, nominal groups and nominalisations.

The system of grammar has been organised by Professor Halliday in two ways, according to rank and according to metafunction (Eds. Hasan & Martin, 1989: 4):

> Most basically they are organised by rank, with clause, group/phrase, and word acting as the points of origin of distinct networks of choice [5, 16, 79]. Rank in other words organises system networks with respect to constituency. The second major organising principle is metafunction. Clause-rank systems (and some group/phrase-rank systems as well) tend to fall into distinctive groupings. At clause rank these are referred to as *transitivity, mood,* and *theme.* Looking across ranks and searching for a semantic interpretation of this patterning Halliday proposed that grammar was in general organised with respect to three major types of meaning. Functional components in the grammar in other words reflects the more general metafunctions: ideational, interpersonal, and textual, with ideational subdivided into experiential and logical.
>
> (Eds. Hasan & Martin, 1989)

As the clauses, groups/phrase, and words are regarded as the "points of origin of distinct networks of choice", the basic unit of rank in the texts is the clause rank. The analysis of the patterns within these ranks exposes the basic structure of the written texts and the semantic meanings of the texts. The intention of analysing the schematic structure of these

texts, the Theme and Rheme and cohesion in the written texts, is to reveal the process of the development of these texts in their structures and the organisation of the information. Viewing the texts as a whole permits the logic governing the use of language to be comprehended organically. The intention of the analysis of Transitivity, nominal groups and nominalisations reveals how the ideational meanings are realised and how the language has become metaphorical.

Due to the limited number of written texts selected for this study, there may be certain limitations in this analysis. Nevertheless, it will reveal certain general trends in the of language features and their function in student abstracts.

5. Conclusion

In summary, SFG provides a useful tool for the analysis of this data. SFG views the structure and the meaning of the language in a holistic way. By analysing the language features in functional terms we can describe patterns of meanings characteristic of certain types of texts.

Chapter 4

Analysis of Schematic Structure and Clause Level Features

Introduction

It was claimed in the previous chapter that the purpose of this thesis is to make the ways of writing abstracts explicit in terms of the genre, language features and their functions. To start the exploration of abstract writing, this chapter covers two main aspects: the generic analysis and the way in which genre and register work together.

First of all, the genre of the abstracts will be discussed and examined so as to provide a basic framework for each text. This discussion involves two parts: the purpose of the abstracts and their schematic structure.

The second part of the discussion deals with the relationships between the genre and the register of the abstracts. This discussion seeks to find how the genre relates to the choices of the contextual variables of field and mode. In the discussion of the genre and the field, the Transitivity patterns of the abstracts will be analysed, in particular, the type of Participants and Processes used in the abstracts. This analysis reveals the relationships between the genre and the field of these abstracts. The choices of the Participants and Processes illustrate the language features which indicate the realisations of the genre at the micro-level.

In the discussion of genre and mode, the textual features will be analysed, such as the Theme and Rheme and cohesion of the abstracts. This textual analysis of the abstracts is to identify the organisational structures of the information from different perspectives, that

is, micro and macro level. The textual features in these abstracts will demonstrate the process of how these abstracts are connected as a whole in the realisation of the genre in each text.

1. Genres of the Abstracts

1.1. The Purpose of the Abstracts

To start with the analysis of the genre of the abstracts, it is very important to identify the purpose of an abstract, as genre is defined as a "goal-oriented" and a "purposeful" activity (Martin, 1987 & Christie, 1987). This definition indicates the significance of purpose in a text.

From the discussion in the previous chapter, one of the characteristics of an abstract is to distill its original research article (Swales, 1990: 179). As a matter of fact, the term "distillation" implies that an abstract is the crystallisation of its research article. It should be always faithful to its research article in terms of its content. This close attachment of an abstract indicates the function of an abstract, that is, an abstract should best represent its research article.

When talking about why and how abstracts, especially those written for the purpose of publication, are distilled, further statements are made by Swales (Swales, 1990: 179-180). The distillation of abstracts, especially those written for the purpose of publication, is effected by the choice of the most critical key-words so as to serve the purpose of making a summarised version of its research article easily accepted by publishers or conference organisers. As mentioned previously, these abstracts were written to be published or presented for a conference (Chapter 3: 38). Thus the "distilled quality" has made them easy to recognise. For example, "In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and mose area" (Text I: 1 sentence). This clearly reveals the field of the source research article to the readers.

Another point of how abstracts are distilled is that in many abstracts, especially those written for abstracting journals, the language used may display such features as incomplete sentences or active verbs without the subjects. (Swales, 1990: 180). In order to see the process of how the abstracts analysed in this study are distilled, the most significant point in this part of the analysis is to show linguistically, how the abstracts actually "distill".

1. 2. The Schematic Structure of the Abstracts

Genre refers to the stages through which the purpose of a text is realised. Martin (1985) distinguishes a number of different genres of factual writings, such as recounts, procedure writing, report writing, explanations and expositional writing. Further distinctions have been made for expositional writing such as analytical and hortatory.

As for the genre of an abstract, it is very hard to put it into any of the specific genres above. This is due to the fact that the genre of the abstract is determined by its research article. Re-examining the research articles in this study (Appendix IV), it can be seen that the articles display certain similarities. Firstly, they all contain an introduction which is to provide an orientation for the readers in terms of the area of investigation. Secondly, they all introduce the methods applied to their studies. This part is more like a recount which introduces the order of the doings. Thirdly, two of the texts demonstrate the experimental results. In this part, the trend is more explanation oriented, demonstrating what the significance or implications of the results are.

To conclude the above, what can be stated is that the abstracts have established their own distinctive patterns in as much as they all deal with reporting the results of experiments. Therefore, they can be called the genre of "experimental research abstracts".

Whichever genre it is, a text usually follows a certain structure as beginning-middle-end or introduction-body-conclusion in order to realise its purpose (Hasan, 1985 & Jones, Gollin, Drury & Economou, 1989). This beginning-middle-end structure provides the

different stages for the realisation of the purpose in the text (Martin, 1985 & Christie, 1987). What needs to be addressed is what the stages are in this abstract genre. These abstracts consist of only one paragraph. It is important to make the way clear in which the stages are signalled. From the analysis of the abstracts, the schematic structure can be outlined as the following.

Text I:

Beginning:	Research problem or area of study
Middle:	Methodology of study
End:	The results of the experiments.

Referring to Text I, the stages can be divided as:

Beginning:

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining. ---------->Problem and area of study

Middle:

The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on these, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear. ---------->Description of study

End:

The results show that minor flank wear reaches a critical value first in finish-machining, so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear. The result also show that the methods is a feasible meaning for on-line tool wear monitoring in finish-machining. ----------> The results of the experiments

Text II:

Beginning	Area of study
Middle:	Description of study

The stages in Text II can be shown as follow:

Beginning:

A flow control strategy for packet switched voice
is introduced and described in this paper. ---------->Area of study

Middle:

It is designed in such a way as to achieve an optimum
network utilisation and speech quality. The performance of
the flow control method is evaluated by means of a simulation
study. The flow control method relies on a prediction of the
current talking/silence state of all voice stations on the network.
A strategy for predicting the network traffic load and two methods
of calculating each station's speech rate, are simulated. ----------> Description of study

Text III:

Beginning:	Area of Study
Middle:	Description of study
End:	The results of the tests.

The stages in Text III are demonstrated below:

Beginning:

The properties of concretes containing instant-chilled
steel slag (I.C.S.) as aggregate are presented. ---------->Area of study

Middle:

The I.C.S. slag possesses good physical and
mechanical properties and has sufficient stability
for use as a coarse aggregate in concrete. ----------> Description of study

Ending:

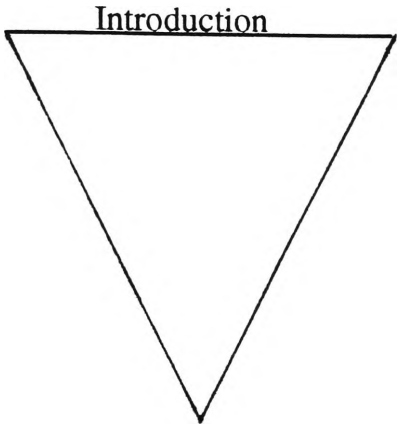
Bond tests have shown that I.C.S.slag exhibits higher
interfacial bond splitting strength with cement mortar
that that of limestone aggregate. The tensile splitting
strength of the slag aggregate itself is higher than
that of limestone. Compressive, indirect tensile and
flexural strengths of I.C.S. slag concretes were greater
than those of corresponding control concretes containing
limestone aggregate. ---------->The results of the
tests

From the above, the functions of the three stages are demonstrated. The first part is the beginning part which proposes the problem and area the researcher is going to study. The second part is the middle part which provides more detailed information about how the study was carried out. The third part is the ending which shows the results of the study. However, Text II is a little bit different from other two texts. There is no third part which indicates the results of the tests. The readers have to read its research article to know what the results are. To a certain extent, Text II does not fulfill the expectations of a research abstract.

What can be concluded from the analysis above is that while the length of these abstracts is only one paragraph, they still basically follow the pattern "beginning-middle-end". This indicates that the length of a text does not determine the structure of a text. As a genre is a "staged, goal-oriented" activity (Martin, 1987), what can be seen is that the writer is trying to achieve the purpose through the different stages as mentioned above. To carry this analysis further to the functions of each stage, what can be seen is as follows.

The function of an introduction is to specify the problem which is going to be discussed or explored in this study. It is acting as a compass which orients or tells the direction of the study. This function is achieved in part by the title of the abstracts. For example, in Text I, the title is "Comprehensive Tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces" which is clear enough to clarify the area of the study.

As the study done by Jones, Gollin, Drury and Economou shows, a general introduction of a research article consists of three stages (Jones, Gollin, Drury and Economou, 1989). They are statement of problem, the interpretation and hypothesis. These three stages usually shift a text from general to particular. The diagram below is drawn from their study (See Next Page).



Problem	General statement or the orientation of the study
Interpretation	What are the issues or problems?
Hypothesis	From what perspective the researcher is going to examine the problem ?

Figure 4. 1: The stages in an introduction.

According to their study, the general introduction of a science paper usually follows this pattern. There are two points which should be made. First, this pattern shows the different stages in an introduction. Second, it tells the functions of each stage. The question is whether the introduction of these abstracts also follows this pattern. If yes, in what way does the introduction follow this structure?

When we look at Text I, it is possible to identify the statement of the problem (underlined). The second part of the introduction does not establish the hypothesis of the abstract, however, there are some implications that the investigation in the study shows the perspective of the researcher.

In finish-machining, geometric accuracy and surface quality are adversely
affected by the tool wear at the minor flank and nose area. ---------->Problem
This paper describes an investigation into "comprehensive" tool
wear estimation, including flank-, crater-, minorflank-, and nose-wear,
based on an analysis of dynamic cutting force in oblique machining.

The introduction structure in Text II and Text III are different from that mentioned above. The beginning does not contain the three parts mentioned above, except that they all possibly have the first part as the statement of the area of the studies.

The analysis of the introduction structure shows that these abstracts may not follow the pattern of the source research article exactly, but they have the elements that should be

contained in the introduction, such as the statement of the study areas to orient the the readers.

The next part is the body of the abstract which is to elaborate the method of the study. It is this part that brings more detailed information about the research or study. Take an example from Text I.

The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on these, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear.

From this example, more detailed information of the method is presented, for example, the purpose of the "force" and the "DA" used in this study. The similarities also can be identified in other two texts.

The final part is the conclusion (Jones, Gollin, Drury and Economou, 1989). The function of this part in these abstracts is to provide the results of the experiment (See Appendix IV). In Text I and III, the results are clearly given, but in Text II, the results are not provided obviously. The reader has to go back to the research article to find out what the results are.

To conclude the above, there are typically three stages in the abstracts. Each stage serves its own function. They can be described as:

Stages	Functions
Beginning:	To state the research problem or the general statement regarding the area of research
Middle:	To describe the methods in the research.
End:	To state the experiments' results.

2. Genre and Transitivity

The above genre analysis outlines the purpose of each abstract and their schematic structures to realise the purposes at the macro-level. This section will carry the analysis further to the micro-level, especially that of the Transitivity patterns in the abstracts. Such

a close analysis reveals the connections between the overall purpose and structural organisation of the texts and their language features (See Appendix V). Its intention is to discover the way in which the genre and field work together in these abstracts.

2. 1. The Participants: the Realisations of the Field of Engineering

It is said that language has three distinctive tasks to fulfil in order to realise the ideational contents. The first task is to "observe the experiential world" by building up a technical vocabulary and giving phenomena names which are significant to the researchers in this specific area (Wignell, Martin & Eggins, 1987). The linguistic means to realise these phenomena is the Participants of the texts. When language is used to observe this specific world of science and technology, new names are given to the different findings. These new findings are usually the ones that are involved in a phenomenon or an event. As a result, technical Participants are formed which are field-specific. Take the following as an example.

Text I

> In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.

From the example, the Participants "geometric accuracy and surface quality" and "the tool wear", to certain extent, reveal the field of the text. This field, in a broad way, can be categorised into the area of mechanical engineering. The selection of the lexis used as the Participants has narrowed down the area of the text to a very specific field.

By listing the Participants in these abstracts, the range of the field can be seen clearly (See next page).

Text I:	Text II:	Text III:
1. geometric accuracy and surface quality the tool wear at the minor flank nose area aggregate	1. A flow control strategy for packet switched voice	1. The Properties of concrete containing instant-chilled steel slag (I.C.S.)as
2. This paper...	2. ...ellipsis	2. The I.C.S. slag
an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force	3. It...	good physical and mechanical properties
3. The force, measured in terms of its three orthogonal components	4. The performance of the flow control method	3. sufficient stability
4. trivariate Autoregressive Moving Average Vector (ARMAV) time series models	5. The flow control method ...	4. Bond tests
5. dispersion analysis (DA)	a prediction of the current talking/ silence state of all voice stations	5. I.C.S.slag
6. features sensitive	6. A strategy for predicting the network traffic load	higher interfacial bond splitting strength
7. The results	7. The simulation results	6. The tensil splitting strength of the slag aggregate itself
8. minor flank wear a critical value		7. Compressive, indirect tensil and flexural strength of I.C.S. slag concretes
9. optimum cutting conditions an appropriate tool change strategy		
10. The result		
11. the methods		
a feasible meaning		

Table 4. 1: The Participants of the abstracts

Generally speaking, the range of the field can be approximately summarised as the following. The Participants in Text I reveal that this text is concerned with an investigation in the mechanical engineering study. This investigation involves experiments, analysis and the results produced by the experiments and the analysis.

The field in Text II deals with the tele-communication engineering field. Through the Participants listed above, this abstract introduces a flow control strategy for packet

The field in Text II deals with the tele-communication engineering field. Through the Participants listed above, this abstract introduces a flow control strategy for packet switched voice. This strategy involves the performance of the flow control method and a simulation study. Further more, the results are also provided.

In Text III, the Participants reveal that this text tackles the material engineering field. As the first Participants shows, this abstract is introducing the properties of a new material. In the process of the introduction to this material, the tests have been carried out. The results of the the test are positive to this new material.

Moreover, the Participants also indicate the changing of the stages in each text, especially those which indicate the last stage in Text I and Text II. It is obvious to see that the last stage in each text is realised by the Participants: "The results" and "Bond Tests" concerning the results of the research.

What is more interesting is that without looking at the Processes in these abstracts, the range of the field covered by each abstract is clearly shown. The next discussion will provide more details about the nature of these Participants.

2. 2. The Types of Participants

What can be drawn from the earlier analysis is that there is not any Participant which refers to any individual human beings. As a consequence of that, the Participants in these abstracts are characterised as impersonal and metaphorical, consistent with the nature of factual writing (Martin, 1985: 3).

As for the impersonality, it can be seen that most of the Participants reflect generic classes. To avoid humans as Participants in the texts makes the texts sound very rational and objective. Of course, the studies or investigations described in the abstracts have been carried out by human researchers which are typically encoded as either Agents or Actors. However, as a piece of factual writing, a more effective way to explain or argue is to

remove the human Participants completely from the written text, particularly, in the scientific writings (Martin, 1985: 25). The motivation for this is often textual. By removing the human agent, the way is opened up for a more effective thematic development. (See Section 3)

The other characteristic of the Participants is the use of metaphorical expressions. In factual writing where only reasons and facts are foregrounded, the use of metaphors is a typical way to remove the human Participants in the writing. The metaphorical expressions "personify" the non-human Participants by turning them into something that can act as Actors in the texts. The following are such examples of metaphorical expression.

Text I.

This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.

Text II.

The flow control method relies on a prediction of the current talking / silence state of all voice stations on the network.

Text III.

Bond tests have shown that I.C.S. slag exhibits higher interficial bond splitting strength with cement mortar than that of limestone aggregate.

From the above examples, it can be seen that the underlined parts are personified. In the first example, the Participant "This paper" functions as an Sayer in a verbal process in the clause. As a matter of fact, "This paper" itself can not actually describe things. It is the human Participant that does the describing. In the second example, the Participant is "The flow control method" which is also a non-human element. "The flow control method" can not rely on anything by itself. Again it is the people who have made it rely on a certain thing. The Participants in the third example are "Bond tests" and "I.C.S. slag", which exhibit similarities to the Participants in the other two examples. The bond tests cannot "show" anything without people doing something behind, and I.C.S. slag cannot "exhibit" anything without people making it. Although the Participants are non-human

elements, they are, to certain extent, acting the roles which are required by people in the abstracts. What is the most significant purpose of using non-human Participants is that they can reveal the ideational content both more effectively and more efficiently than those human Participants do in the abstracts of science and technology.

In summary, the types of Participants reflect the technical nature of the texts. At the clause level, the genre is realised by, to certain extent, these impersonal and metaphorical Participants. As a consequence of the impersonality and metaphor, the ideational meanings in these abstracts are straightly and clearly realised. However, the Participants are not the only the elements to realise the genre of the texts. Other factors should be also taken into consideration, such as the Processes in the texts. This discussion will be presented in the following section.

2. 3. The Types of Processes

Field is also realised through the "goings on" in the texts. Besides the generic and metaphorical Participants, the types of Processes used in the abstracts are also linked with the genre. As the analysis of the Processes in these abstracts show, most of the Processes used in these abstracts are Material Processes and Relational Processes (See Appendix V). The following tables are the quantities of different types of Processes used in the abstracts.

Text I

Process	Material	Mental	Behavioural	Identifying	Attributive	Extistential
12	11	----	------	1	-----	-------
%	92%	----	------	8%	-----	-------

Table 4. 2: The types of Processes in Text I.

There are twelve clauses in this text. Each clause has one Process. Among these twelve Processes, there are eleven Material Processes which make up 92% and one Attributive

Process which makes up 8%. This indicates that the abstract mostly tells the what has been done and what something is.

Text II

Process	Material	Mental	Behavioural	Identifying	Attribute	Existential
7	7	----	------	------	------	------
%	100%	----	------	------	------	------

Table 4. 3: The types of Processes in Text II.

In the second text, it shows that there are seven Processes. The Material Processes make up 100%. Mostly it tells what has been done.

In the third text, the Processes are varied compared with those in the other texts. In addition to the Material Process, four Relational Processes are used, two are Attributive, the other two are Possessive.

Text III

Process	Material	Mental	Behavioural	Identifying	Attributive	Existential	Possession
7	3	------	-----	----	2	-------	2
%	42%	-------	------	------	29%	-------	29%

Table 4. 4: The types of Processes in Text III.

There are seven Processes in Text III, three of which are Material Processes making up 42%, and two are Attributive making up 29%. The other two are Possessive which also makes up 29%. Besides telling what has been done, there are also some descriptive expressions.

The high frequency of the use of Material Processes may indicate that these texts are more "action" oriented (Janet Jones, 1988: 69). This is because the function of a Material Process is to demonstrate what has been done in the real world. It is an expression of "Doing Thing". According to Halliday, these Material Processes "express the notion that some entity 'does' something - which may be done 'to' other entity". (Halliday, 1985 A: 104). In addition to that function, however, Material Processes also have different

degrees as the sense of "Concrete" and "Abstract" (Halliday, 1985 A: 104-105). The line between what is a concrete Material Process and what is an abstract Material Process, although difficult to draw, nevertheless, still can be distinguished by certain means. "With more abstract Processes, we often find active and passive forms side by side with very little difference between them. ... if the passive form is used, we can probe for an explicit Actor - we can ask *who by* ?, whereas with the active form we cannot" (Halliday, 1985 A: 104-105). The types of Material Processes across these three abstracts are listed as following. The abstract processes are marked with the sign "*".

Text I

Process	
1. ...are ... affected* by	the tool wear at the minor flan and nose area
2. ...describes*	an investigation into "comprehensive" tool wear estimation...
3. ...was used* to develop time series models	trivariate Autoregressive Moving Average Vector (ARMAV)
4. ...was used* to extract	features sensitive to the rate of various types f wear
5. ...show*	
6. ...reaches*	a critical value first
7. ...must be determined*	
8. ...show	
9. ...is	

Table 4. 5: The Processes in Text I.

Text II

Process	
1. ...is introduced*...	
2. ...described*...	
3. ...is designed*...	
4. ...is evaluated*...	
5. ...relies on	a prediction of the current talking / silent state of all voice stations on the network
6. ...are simulated*...	
7. ...are presented*...	

Table 4. 6: The Processes in Text II.

Text III

Process	Medium
1. are presented*	
2. possesses	(Possession)
3. has	(Possession)
4. have shown*	
5. exhibits	higher interfacial bond splitting strength with cement mortar ...
6. is	(Attributive)
7. were	(Attributive)

Table 4. 7: The Processes in Text III.

From the tables above, it can be seen that these three abstracts contain primarily Material Processes, especially Text I and Text II. These Material Processes are mostly abstract abstract Processes, as the an explicit Actor can be probed (Halliday, 1895 A: 104-105). Text III is a little bit different from the other two texts. It has four other types of Processes known as Attributive and Possession. For the rest, it is Material Processes among which two are abstract Material Processes. This happens due to the types of Participants and the roles in the abstracts.

As the previous analysis shows, the Participants are non-human Participants and some of these are metaphorical. As a result, the metaphorical Participants are used to take the place of those human individuals who actually are the external causes of the process - the Agents. In Text II, for example, most of the Material Process are concrete ones, and they are expressed in passive forms. If they are converted into active forms, the Agent - the human Participants will reappear. Take the following as an example:

A flow control strategy for packet switched voice is introduced and described in this paper.
Goal

The researcher will introduce and describe a flow control strategy for packet switched voiced in this paper.
Goal

The example, although it is agentless, still can be probed for an explicit Actor by asking who by ? In its active voice, the actor is made explicit, and the original Goal in the first

example is still acting as the Goal. The function of the most Participants in Text II is Goal while in their active voice, their status remains the same.

Whichever the types of Material Process, abstract or concrete, in the abstract ones, the agent or the external causer is hidden away. What the researchers intend to tell is through the use of the metaphorical expressions and the passive voice of the language.

Another function of using the Material Process is that some of these Material Processes are playing a similar role to Mental or Relational Processes, rather than just simply recording what happened or what has been done. For example, in Text I, the establishment of the thesis is set up as following:

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.

The function of the Material Process is to establish the theory on which the research is based rather than just to recount that something has happened in this area. It is because the geometric accuracy and surface quality are affected by the tool wear, therefore, the following investigation is carried out. This actual happening has, to certain extent, become a theoretical hypothesis. The purpose of the later part of the study is to prove this hypothesis is the truth. In other words, this Material Process is used to establish the argument of the paper. The Material Processes in Text II do not have such a function as to build up the hypothesis of the study. However, the Material Process used in the first clause has set up the purpose of the abstract. The is shown as below :

A flow control strategy for packet switched voice is introduced and described in this paper.

The Processes here fundtion to declare that the purpose of the research article is to introduce and describe a flow control strategy, rather than recording what has been done in the past.

Similar to Text II, Text III also uses a Material Process to clarify the purpose of the research article. It starts with (See next page):

The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregated are presented.

It is also hard to say that this Material Process is used in order to tell what has happened, because the Material Process in this clause complex implies the purpose of the research article as presenting (properties)

Besides the use of Material Processes, in Text III, however, there are also some Relational Processes used. Halliday identifies three types of Relational Processes (Halliday, 1985: 112). They are Intensive, Circumstantial, and Possessive. In Text III, the Relational Processes are Possessive Processes and Attributive Processes. The use of the Possessive Processes, in fact, reveals a similar function to the Material Processes discussed above in Text I.

The I.C.S. slag possesses good physical and mechanical properties, and has sufficient stability for use as a coarse aggregate in concrete.

The existence of the possessive relationship between these two things sets up the hypothesis of the study. It is under this hypothesis that the study has been carried out. The purpose of the use of Possessive Processes is also to seek an argument that the I.C.S. slag is better that other materials.

The other kind of Relational Process is the Attributive Process, which indicates the descriptive relationship between the Participants. Its purpose is make comparison between two things. They tell the "quality (intensive), as a Circumstance -- of time, place etc. (Circumstantial) or as a possession (Possessive)" (Halliday, 1985 A: 112). In Text III, the Processes used are to show the quality of the Carrier.

3. Theme and Rheme - the Textual Features

3. 1. Introduction

The previous analysis demonstrates the relationship between the genre and the contextual variable of field. The analysis shows how the ideational choices relate to the genre of the abstracts. In this section, the textual features of the abstracts will be analysed in order to

see how these features relate to the genre of the texts. If the analysis of the schematic structure is to reveal the organisation of the information of the texts, then the analysis of the Theme and Rheme is to examine the development of the information between each clause and how the information moves forward from one clause to another. The analysis of the Theme and Rheme shows the texture of information in the abstracts (See Appendix VI). The choice of Theme is very important in terms of controlling the organisation of the paragraph and the text and the development of the information. By analysing the Theme-Rheme structure, a reader can get an insight into the texture and understand what the author intends to tell and the nature of the underlying concerns.

3. 2. The Types of Themes in the Abstracts

Abstract writing belongs to the domain of factual writing. The analysis of the Transitivity of the abstracts has already shown the impersonality and the frequent use of metaphor -- the characteristics of factual writing (Martin, 1985: 25) through the choices of the vocabulary. This will also influence the types of Themes and Rhemes in the texts. As previously mentioned (Chapter 2), there are three kinds of Themes in English. They are Topical, Interpersonal and Textual. Most of the Themes in these texts are Topical Themes of an impersonal nature. The following analysis has shown the type of Themes which appear in the abstract texts.

	Text I	Text II	Text III
Interpersonal Theme	0	0	0
Topical Theme	10	6	6
Textual Theme	3	0	2
Marked Theme	1	0	0

Table 4. 8: The types of Themes in the abstracts.

From the analysis of the thematic structure in the abstracts, it has shown that most of the Themes are Topical, or Textual as well as Marked ones. These Topical Themes have greatly impersonalised the abstracts by emphasising the information regarding a study or an investigation rather than the researchers who are involved. From these themes, they

can hardly show a specific author or the personal attitude, feelings or emotions towards the matter. This has happened because of the choices of the technical terms in these abstracts. The followings are the examples taken from the abstracts.

1. The force, measured in terms of its three orthogonal components...
2. A flow control strategy for packet switch voice...
3. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate.....

From the above, it is seen that all the Themes reflect the facts but not any specific individual who has been involved in these studies.

3. 3. Theme and Rheme System as Organisation of Information in Clauses

From the analysis of the genre of the abstracts, it is claimed that the development of ideas or information has been realised through the different stages in a text. Each stage carries the development of the ideas into a new or different level. Bringing this information development into a micro level, what can be seen is that a factor which influences the shifts of the stages in the abstracts from one to another actually is the Theme part in the abstracts. A function of Theme and Rheme is that the messages in a text are linked. They closely relate to each other. The flow of information is structured by Theme and Rheme. This is an important feature in English discourse (Halliday, 1985 A: 56).

The structuring of the message, in a text, refers to the ways in which the writer interacts with the reader. Through organisation of the clause, it has been made clear to the reader what is old information or predictable, and what is new information and unpredictable. This is called "the Given and the New" (Halliday, 1985 A: 275). However, this Given and New is different from Theme and Rheme. As Halliday has stated, "Theme + Rheme is speaker-oriented, while Given + New is listener-oriented" (Halliday, 1985 A: 278). In written text, the indications are that the Given + New can be thought as reader-oriented and the Theme + Rheme can be viewed as writer-oriented. Take the first clause as an example (See next page).

Text I

1. In finish-machining, geometric accuracy flank and surface quality Given ---------->	are adversely affected by the tool wear at the minor and nose area. <---------- New

In this clause, the Given is "In finish-machining, geometric accuracy and surface quality" which is the Theme of the clause and the New is "are adversely affected by the tool wear at the minor flank and nose area" which is the Rheme in the clause. The Given part is presented by the author as "recoverable" while the New part is addressed as "unrecoverable" (Halliday, 1985 A: 277).

The Given and New or Theme and Rheme in a clause indicates the close semantic relationship between the information structure and the thematic structure. The purpose of choosing the Theme from the Given is to locate it as the focus information. Regarding the Theme and Rheme function, it is claimed in the study done by Jones, Gollin, Drury and Economou that the choice of Theme is very important in the process of controlling the organisation and development of different parts of a text. This indicates that one function of Theme is to control the paragraphs in a text and how to develop the text as a whole. Also, in their study, it is pointed out that the Theme of a clause or a sentence can depend on the Rheme of the last sentence or clause or some previous sentence or clause. If the Theme of each clause is not clear, the whole text will appear to be disjointed. When refining the function and relationship between Theme and Rheme, it is said:

> Successful writing links ideas from one sentence to the next within paragraphs.
> If you look at the main clause of a sentence you can divide it into two parts. Roughly speaking, the part before the verb contains the Theme (i.e. what the sentence is about). The rest of the clause is called the Rheme (i.e. it contains some new information that the writer gives the reader).
> all or part of this new information is usually carried in to the next sentence, where it becomes the Theme. This old given information is often expressed in different words, but the meaning is carried on.
>
> (Jones, Gollin, Drury, Economou, 1989).

In a text, the first Theme is typically important, since it may introduce the topic of the paragraph or the texts. As these abstracts show, the first Themes in these texts are all

concerned with the subject matter which the authors intend to report on. The first Themes in these abstracts are listed as below:

Text I

In finish-machining, geometric accuracy and surface quality ...

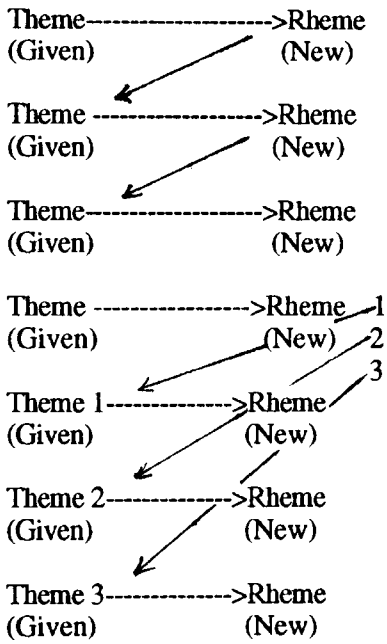
Text II

A flow control strategy for packet switched voice...

Text III

The properties of concretes containing instant-chilled steel slag (I.C.S) as aggregate...

Beginning with these Themes in the abstracts immediately positions the readers to the central concern of the abstracts. The new information generally coincides with the Rheme. As for the pattern of the development of the Theme and Rheme, it can be described the following:



or like this:

(Figure 4. 2: The organisations of Theme and Rhemes: Jones, Gollin, Drury and Economou, 1989)

The first pattern shows the close relationship between Theme and Rheme in developing a paragraph. As Irvin stated in his book, the development of Theme and Rheme pushes the development of information in a text (Irvin, 1980). What is new in the Rheme becomes the given in the next clause. The second pattern shows that one main Theme is elaborated in several following clauses.

In the abstracts, the development of Theme and Rheme is a sort of combination between the these two patterns. The first Themes in the abstracts are all the main Theme in the texts.

Text I

In finish-machining, geometric accuracy and surface quality... Theme

The first Theme consists of two parts: a Marked theme and a Topical theme. They set up the topic of what the paper is about.

Text II

A flow control strategy for packet switched voice... Theme

This first Theme is from the title of the paper and also tells the reader what the researcher intends to discuss.

Text III

The properties of concretes containing instant-chilled steel slag (I.C.S) as aggregate... Theme

This first Theme is also from the title of the paper. It also tells what the researcher is going to say in the following part of the abstracts.

Abstract writing is limited by its space and length (Swales, 1990). It requires the writer to directly come to the point of the study. In writing an abstract, the first Theme plays an important role in revealing the topic of the paper. If the first Theme does not closely follow the topic, the abstracts may not be effective enough in clarification of the topic of the paper.

The later development of Themes is based on the information of the Rhemes in the previous clauses (See Appendix VI). In Text I, the second Theme is "this paper". The second Theme provides new information which seems to have nothing to do with the first Theme or Rheme. In the following part of the text, the Themes are a further development of the second Rheme. They are about the investigation done by the researcher.

Different from the first text, the second text develops its Themes and Rhemes in a very close way. In Text II, the first Theme is "A flow control strategy for packet switched voice". Next Theme is "It" which refers to the first Theme. The following two Themes are "The performance of the flow control method" and "the flow control method". These two Themes can be regarded referring to the first Theme "A flow control strategy for packet switched voice". It indicates that the first Theme contains two parts: first is the performance of the method, second is the method itself. This is similar to the second pattern described by Jones, Gollin, Drury and Economou (Jones, Gollin, Drury & Economou, 1989). The later part of the development of the Theme and Rheme in Text II follows the first pattern of their study (See Appendix VI).

The development of Theme and Rheme in Text III is more or less the same as Text II, which is similar to the second pattern described by Jones, Gollin, Drury and Economou. The first Theme is "The properties of concretes containing instant-chilled slag (I.C.S.) as aggregate". The second Theme is "The I.C.S.slag" which is part of the first Theme. Next Theme is "Bond tests" which is new information. The next one is a repetition of the previous Theme. Later the Themes are about the splitting strength and comprehensive, indirect tensile and flexural strengths. These two are parts of the I.C.S. slag.

3. 4. Textual and Marked Themes: the Signal of Shifting the Stages

Textual Theme, as Professor Halliday describes, may contain different textual elements as "(i) continuative, (ii) structural and (iii) conjunctive Themes" (Halliday, 1985 A: 54). Continuatives signal a new start or a new shift in a text. The function is to show a response to a topic. Usually, they appear in spoken language. Structural and conjunctive Themes consist of conjunctions and relatives.

As the mode of these texts is written, no elements as characteristic of the spoken language can be found. With the development of the information in these abstracts, the Textual and Marked Themes signal the logical relationship of the texts. In Text I, there three Textual

Themes, "that", "so that", and "that" (See Appendix VI). The function of the conjunction "that" is to introduce a new clause which is a subordinate one. It does not have any specific thematic function. The conjunction "so that" is not only to introduce a new clause, but also shows the logical relationship in a clause complex.

In Text II and III, there is only one Textual Theme "and" which is to expand the clause.

Summarising the relationship between the Textual Themes and the grammatical intricacy, it can be said that the result of the low grammatical intricacy also causes the low frequency of the Textual Themes in the abstracts.

Marked Theme, as it is defined by Professor Halliday, is "something other than the Subject, in a declarative clause", (Halliday, 1985 A: 45). The most common Marked Themes are adverbial groups and prepositional groups. In Text I, there are some Marked Themes (See Appendix VI). The first clause starts with a marked theme.

Text I

In finishing-machining,	geometric accuracy and surface quality	are adversely affected by the too wear at the minor flank and nose area.
Marked Theme	Topical Theme	Rheme

Here the Marked Theme is foregrounded. Immediately, it makes the meaning more specific in terms of time when the process of finish-machining starts. Following the Marked Theme, there comes the Topical Theme "geometric accuracy and surface quality" which reveals the ideational content of the text.

Summarising the Marked Theme in the text, as a matter of fact, it introduces the the real Theme (Topical Theme) in the clauses. Their functions are: first to emphasise the part which the researcher intends to say, second to show the immediate relationship between this clause and the previous one and third to act as introduction to the Topical Theme in this clause.

The analysis of Theme and Rheme can show the organisation of the information of the texts and the ways in which this information is developed. However, a further analysis of the texts is needed in terms of the relationships between the information and how the information is connected in the texts. The following section is the analysis of the cohesion in the texts so as to show the semantic relationships between the clauses in the texts.

4. Cohesion in the Texts

The analysis of Theme and Rheme and schematic structure reveals the linguistic features in the texts in terms of the organisation and the structure of the information. Looking at an abstract as a whole piece of text, another thing that needs to be analysed is cohesion, because cohesive elements connect a text as a whole entity. The definition of "cohesion" given by Professor Halliday is "non-structural resources for discourse" (Halliday, 1985 A: 288).

> The concept of cohesion is a semantic one; it refers to relations of meaning that exist within the text, and that define it as a text.
>
> (Halliday & Hasan, 1976: 6)

"Cohesion is expressed partly through grammar and partly through the vocabulary" Halliday & Hasan, 1976: 5). Thus, there are two kinds of cohesive relations: Grammatical Cohesion and Lexical Cohesion (Halliday and Hasan, 1976: 6). The function of cohesion contributes to the quality of "texture" (Halliday, 1985 A: 291).

4. 1. Analysis of the Texts

The texts will be analysed in terms of the different aspects in cohesion. They are reference, ellipsis and substitution, conjunction and lexical cohesion.

Reference

Among the three types of the Reference cohesion, Personal, Demonstrative and Comparative, the analysis shows that in the abstracts, there are a few cohesive elements of such kind (See Appendix VII). The following table shows the sorts of reference items in these abstracts.

Types of Reference	Text I	Text II	Text III
Personal	0	1(No. 1)	0
Demonstrative	2	1	2
Comparative	0	0	3 (No.3, 4 & 5)

Table 4. 9: The types of the Reference.

The significance of the analysis shows that it is very hard to draw cohesive ties among the abstracts. Although "the" - the definite article appears frequently in these abstracts, it is very hard to trace within the texts. From the beginning of the abstracts, mostly new things are introduced all the time. For such a reference item, it is called "Cataphoric" which means that "*the* can never refer forward cohesively", and it is only a "structural type" (Halliday & Hasan, 1976: 72).

In the study done by Jones, Gollins, Drury and Economou, they have stated that:

> Scientific exposition characteristically contains a great deal of generic and exophoric reference. Much of the endophoric reference is cataphoric, particularly of the esophoric variety. Thus, the long cohesive anaphoric chains of demonstrative and personal characteristic of narrative genres are not usually found.
>
> (Jones, Gollins, Drury and Economou, 1989)

The significance is that the frequency of the reference items, as a matter of fact, is caused by the genre of the abstract. These three abstracts all share in common in terms of using the reference items. The analysis of Reference cohesion shows that most of the cohesive items are cataphorical reference. This indicates a typical language feature of this kind of texts in terms of Reference cohesion.

Another kind of Reference is Comparative reference. A function of comparative reference is to set up a relation of contrasting. Comparative reference can be general comparison, or particular comparison (Halliday & Hasan, 1976: 76). Text III has two comparative

reference, "higher" and "greater" which belongs to the particular comparison. These two epithets reveal the quality of the objects that have been described in the text.

Ellipsis and Substitution

In these abstracts, there is not much Ellipsis and Substitution. In Text I there is only one Substitution "these". Text II does not have any Substitution at all. Other substitutes appear in Text III. There are: "that" and "those". It is because of the use of the comparative reference in the text. The two substitutions in Text III is as following:

that I.C.S slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate.

Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate.

The purpose of using the substitutions is to avoid the repetitions in the text, especially when these two elements are close to each other in a clause in terms of the positions.

Ellipsis or omission is a kind of substitution. In these abstracts, ellipsis appears in certain parts (See Appendix VII). From the analysis of the Theme and Rheme, Transitivity and the analysis of the clause complex, ellipsis can be found. Mostly, the Themes, or Participants are omitted in a clause. This indicates between two subordinate clauses, when the action is done by the same Participant or the Theme is the same one, the latter one can be omitted. This does not affect the comprehension of the texts. The abstracts are limited by the word length. Using the ellipsis is one way of to be more explicit.

Conjunctions

Conjunction is the system used to express the logical relationships in a text. As it is discussed in the previous part of Theme and Rheme, there are not many Textual Themes in the texts (See Appendix VI). Therefore, there are not many conjunctions explicit in these texts either (See the Appendix VIII). However, the logical relation is still set up in

these texts. This is due to the implicit use of lexical cohesion. The lexical cohesion shows another typical language feature in these abstracts.

Lexical Cohesion

The cohesive items discussed above are grammatical cohesive items in the texts. Lexical cohesion seeks to demonstrate the cohesive effect achieved by the vocabulary selected in these texts.

The analysis of these abstracts exposes two major characteristics. They are the limitation of the selection of the vocabulary due to the fact that the abstracts must closely reflect the source article, and the relationships established by these vocabulary items (See Appendix IX).

The analyses show that the "fields" are restricted to two or three areas, ensuring tight cohesion. Minor strings referring to the article and the research study, and major strings referring to the object under investigation (its parts/properties/etc.) and the nature of the intervention. There are a couple of instances of repetition. For example, in Text I, the expression "finish-machining" is repeated a few times, in Text II, the "flow control strategy" is also repeated, at least, twice, and the same to the "I.C.S." in Text III.

5. Conclusion

In this chapter, the genre of the abstracts and the textual features have been analysed so as to demonstrate the schematic structure and the organisation of the texts.

As for the genre of the abstracts, their schematic structure will vary according to the purpose of its article. When the article's purpose is to report on an experimental research project in engineering, we can say the function of the beginning part is to give a general statement in order to guide the reader into a specific field of study and to state the area to be researched. The middle part is to introduce the method(s) or experiments involved in the study. The ending part presents the results from the experiments.

The genre of the abstracts also influences other language features of the abstracts. The analysis of transitivity shows that most of the Participants are generic, non-human Participants rather than a specific individual, and many of are used metaphorically. Themes are typically Topical and consist of lengthy nominal groups.

From the analysis of cohesion in the abstracts, it is shown that the reference items such as "the" is used frequently. However, it is very hard to find the cohesive ties within the texts. This may be because the discourse of the abstracts is science and technology, where mostly cataphoric reference is used. Another typical point is that there are not many explicit conjunctions in the abstracts. The logical relationship between each clause remains implicit. The relationship between the lexical cohesion is mainly Meronymy, Hyponymy or Repetitions.

However, there are other factors that influence the language features in the abstracts. This involves the analysis of the mode of the texts. The next chapter will carry the analysis below the clause level so as to provide a more detailed analysis of the language features in these abstracts. The micro analysis of the texts makes it possible to see the nature of these language features.

Chapter 5

Linguistic Features below Clause Level

Introduction

The previous chapter provides the analysis of the language features and their function both at the macro-level and the micro-level. In this chapter, the analysis will go below the clauses. The intention is to identify the language features at a group level. This analysis at the group level discloses what is behind those language features demonstrated in the previous chapter.

In this chapter, what will be examined at the group level is the nominal groups and the nominalisations in the abstracts. The purpose is to see the function of the nominal groups and the nominalisations in the process of realising the ideational content of the texts, and thus highlight the way in which the language of the abstracts condenses or "distills". The analysis will also cover the consequences of the use of the nominal groups and nominalisations. These consequences will include the lexical density, grammatical metaphor and the grammatical intricacy in these abstracts.

1. Nominal Groups and Nominalisations--the Realisations of the Ideational Contents at Group level

1. 1 Introduction

Transitivity can be regarded as the way of realising the ideational content at clause level. At the group level, Participants in transitivity Processes are realised by nominal groups. A nominal group, then, is one of the ways to reveal the ideational content of texts. A way in

which the ideational meanings are realised by the nominal groups is to specify the things or phenomena into increasingly narrow and detailed areas. The following section will provide a discussion of how they specify and detail the happenings and phenomena of the world of engineering abstracts.

1. 2. Functions of nominal groups

According to Halliday, a group is defined as a "WORD COMPLEX" which refers to "a combination of words built up on the basis of a particular logical relation" (Halliday, 1985 A: 159). A group is an expansion of a word.

In English, there are three main groups, one of which is called the nominal group. In any nominal group, there are one or more functional elements. They are Deictic, Numerative, Epithet and Classifier. In Halliday's grammar, the functions of these elements are stated as follows (Halliday, 1985 A:160).

Deictic: "The Deictic element indicates whether or not some specific subset of the Thing is intended; and if so, which. It is either (i) specific or (ii) non-specific."

Numerative: "The Numerative element indicates some numerical feature of the subset: either quantity or order, either exact or inexact."

Epithet: "The Epithet indicates some quality of the subset, ...This may be an objective property of the thing itself; or it may be an expression of the speaker's subjective attitude towards it,... ."

Classifier: "The Classifier indicates a particular subclass if the thing in question,... . Sometimes the same word may function either as Epithet or as Classifier with a difference in meaning."

Verbs as Classifier: "Verb as classifier contains the meaning of lasting attribute. It emphasis the process of something that is going on."

Qualifier: Qualifier can be defined as the elements following the Thing. "Qualifier are embedded". It has a function of characterising the Thing.

Post-Modifier: Post-modifier can be defined as the elements following the Thing. It has a function of sub-categorisation, which modifies the Thing.
(Halliday, 1985 A: 160-171)

In any nominal group, there is a semantic core which is called the "Thing" or the head noun. It can be realised by "a noun, proper noun, or (personal) pronoun"(Halliday, 1985 A:164). The function of the Thing in one nominal group is to expose the experiential content. From the analysis of the nominal groups in these abstracts, the Things are all nouns, many of which are metaphorical ones.

The process of specifying can be seen by examining one of the nominal groups from the abstracts:

Three-dimensional	dynamic	cutting	forces
Epithet	Epithet	Classifier	Thing

This nominal group contains two Epithets, a Classifier and a Head Noun or the Thing. Surrounding the Thing in the nominal group, these linguistic elements function to build specific meanings. Forces can be of many kinds. In this particular nominal group, the forces are classified as "cutting forces". Based on that, more descriptions have been built up as "dynamic cutting forces". Then, the specific forces to which it refers in the abstract are "three-dimensional" ones. In other words, there might be other kinds of forces like "two dimensional", but what will be described is the three dimensional ones.

Nominal groups assist in the "ordering and explaining" of the world (Wignell, Martin and Eggins, 1987: 25). In this process of ordering, there are three distinctive ways that the language is used.

> First, language is used to "observe" the experiential world, through the creation of a technical vocabulary - a process of dividing up and naming those parts of the world which are significant to geographers. Second, language is used to "order" the experiential world, through the setting up of field-specific taxonomies. And third, language is used to "explain" the experiential world, through the positing of implicational relations between natural or man-made states.
>
> Wignell, Martin, and Eggins, 1987: 25)

The first task is realised by the Participants which are specific to a particular field, as it is shown in the earlier part of the thesis. The second task is fulfilled by ordering what have been created through the observations of the experiential world. That is to classify phenomena these parts and establish an organic system. This system is the field-specific

taxonomies. These field-specific taxonomies will explain the meaning of the experiential world through the relationships set up between the lexical items chosen.

What is meant by "taxonomy" refers to the way of organising things in order. As it is claimed in "The Discourse of Geography":

> A taxonomy is an ordered, systematic classification of some phenomena based on the fundamental principles of superordination (where something is a type of or kind of something else) or composition (where something is a part of something else).
>
> (Wignell, Martin, and Eggins, 1987: 27)

From what is stated above, it can be said that a function of a taxonomy is to organise phenomena into different categories. To the researchers, these phenomena are concerned with what they have observed and studied in their own fields. The text analysis shows that the phenomena in these three abstracts deal with different fields of the studies which are only relevant to the researchers (See Appendix X). The analysis shows the number of the linguistic elements and the types of them used by the researchers to order the meanings of the experiential world in these three abstracts. The analysis of the nominal groups shows that most of the elements frequently used in these nominal groups are Epithets, Classifiers, Deictic, Qualifiers, and Post-modifiers (Appendix X). The table below shows the numbers of the different elements used in the abstracts.

	Deictic		Epithet	Classifier	Numerative	Thing	Qualifier
	Demonstrative	Possessive					
Text I	15	0	23	28	1	38	17
Text II	19	1	6	21	1	24	7
Text III	8	0	19	20	0	23	13

Table 5. 1: The types of the linguistic items in the nominal groups.

The typical elements shown in Table 5. 1. are the large amount of the Classifiers, Epithets, Things and Qualifiers. The large number of Qualifiers used indicates that the nominal groups are mostly very long and heavy in terms of the information carried. An example is given below (See next page):

Text III:

The	properties	of concretes	containing	instant-chilled	steel	slag (I.C.S.)	as aggregate
Deictic	Thing	Qualifier					
		Thing	Post-modifier				
Circumstance			Process	Participant			
			Possession	Possessed			Purpose
				Classifier	Class.	Thing	

It is significant to see how the Thing is modified and sub-categorised by these elements as Deictic, Classifier, Qualifier and Post-modifier. There are twenty-three Epithets used in Text I, six in Text II and nineteen in Text III. These Epithets express the quality of the Things in the experiential world. What is more significant is that these Epithets are all from an objective perspective as opposed to the attitudinal Epithets often found in other genres. Their function focuses on defining and describing the experiential field, such as "comprehensive", "geometric", "switched", "interfacial" and so on.

Another point to which attention should be drawn is the type of the Deictic used in these abstracts. There are two kinds of Deictic elements. One is demonstrative which refers to "some kind of PROXIMITY", the other is possessive which refers to "PERSON as defined from the standpoint" (Halliday, 1985 A: 160). Most of the Deictic modifiers used in these abstracts are demonstrative Deictic. Although there is only one possessive Deictic in Text II as "stations' voice" which indicates where the thing belongs to, still it does not indicate any personal meaning in the abstract. To summarise the above discussion, it can be seen that the types of modifiers used in these abstracts reflect the impersonality - a characteristic of the genre of these abstracts.

In the process of ordering the experiential world, different linguistic elements play different roles. These roles are shown in the following examples:

1.

a	multi-dynamometer	measurement
Deictic	Classifier	Thing

2.

an	integrated	3-D	accelerometer
Deictic	Epithet	Classifier	Thing

3.

A	multi-dimentional	system	identification	technique
Deictic	Epithet	Classifier	Classifier	Thing

The Deictic in the abstracts is to specify the amount and the specificness of the Thing in a nominal group. The Epithet is used to specify the quality of the Thing in the nominal groups. The Classifiers are to put the thing into different categories. Numerative reveals the size of the Thing. As stated before, the taxonomy system is concerned with a kind of or a part of. From the analysis of the examples, it can be seen that the Epithets and Classifiers in these texts realise the meaning of something as a kind of or a type of something while the Qualifiers with "of" realise the meaning as being "part of" something. In other words, they further describe the Thing. This can be demonstrated from the following example in the text analysis.

Text III

Instant-Chilled	Steel	Slag	Aggregate
Classifier	Classifier	Classifier	Thing

The above nominal group is typical of the sort of modification found in these abstracts: a Thing modified by a number of Classifiers, two of which are realised by nouns. The kind of steel slag aggregate is "instant-chilled". The relationship between the "Steel" and "Slag" is that it is this kind of slag (steel not anything else) used as aggregate.

Text III

the	tensile	splitting	strength	of	the	slag	aggregate
Deictic	Epithet	Classifier	Thing		Qualifier		
					Deictic	Classifier	Thing

This nominal group can be divided into two parts. The first part of the nominal group is to tell the name of the Thing as "the tensile splitting strength". The second part is to specify that this strength belongs to "the slag aggregate".

Most technical terms in the English of science and technology are nominal groups. These technical terms are regarded as nominal group constituents, usually with such a structure as Things or Classifier^Thing compounds (Wignell, Martin & Eggins, 1987). It is not an accidental phenomenon, because the process of classifying and organising with language first requires turning the phenomena into Things or nouns. In these abstracts, there are

many such constructions used to realise the technical terms. The following are some examples from the abstracts.

Text I:

finish-machining:	The verb "finish" is nominalised. Thus it is frozen to be a thing to modify the other nominalisation, machining. Machining, in reality, is an action. This action is converted into a Thing to name a phenomenon.
tool wear:	The noun "tool" is functioning as a classifier to modify the nominalisation "wear" so as to construct a technical term.

Text II:

flow control:	The verb "flow" is nominalised as a classifier to modify the nominalised Thing "control" so as to make a technical term.
speech quality:	The word "speech" is also a nominalisation functioning as a Classifier to modify the Thing "quality". Thus a technical terms is formed.

Text III:

bond tests:	The noun "bond" is a classifier to modify the thing "tests" so that the technical term is formed.
cement mortar:	The noun "cement" is a classifier in this nominal group to modify the the "mortar" to build a technical term.

Among all the technical terms, most of them are built by the nominal groups whose structure is Classifier^Thing. This happens because the abstracts "pack in" lots of technical information which is condensed or "distilled", especially, in lengthy discussion, descriptions and explanations. Relating to the length of the abstracts, what is required is that the authors have to clearly and effectively provide enough information in the limited length for the readers. Therefore, the pattern as Classifier^Thing frequently occurs.

The effect of a detailed specification of phenomena means that most of the lexis are nominal groups containing different meanings or information. These highly information-packed nominal groups result in the high lexical density in these abstracts. This naming process is also a cause of the high level of grammatical metaphor. This is because many actual happenings have been converted into things. These things are so metaphorical that they have lost their original appearance in the abstracts. For example, the realisations of the actions, instead of using verbs or verbal groups, are nominalised, and the realisations of descriptions of quality of the different things, instead of using adjectives, are turned into nominalisations. These incongruent expressions have directly resulted in the high

level of grammatical metaphor. These language features reveal the function of the abstracts, which is to distill the research articles. This will be discussed later in the chapter.

As shown above, the ways of realising the ideational contents by these nominal groups involve naming and ordering. In the process, the actual happenings and the information are taxonomised and organised. As a consequence, the lexical density and grammatical metaphor are quite high in the abstracts. These issues will be further pursued in the following section.

1. 3. Nominalisations

In this section, the Nominalisations - one type of grammatical metaphor - will be discussed. The major function of nominalisations in these abstracts is to condense the meanings found in the source article.

Quite often, an abstract is limited by its word length. Like these abstracts, the limitation of the word length is about 150-200 words. Therefore, it is very important for researchers to effectively, completely and economically use the language to express the meanings of their research article. In the written language, nominalisation is one way to fulfil the tasks above. That is the meaning condensation. A study by Drury indicates that the meaning condensation in a written text can cover the meanings which actually has spanned pages in its research article (Drury, 1986). In these abstracts, where the word length is strictly limited by the requirements, meaning condensation is the most significant means to fully express the concerns of the research article. In the language system, this function is achieved by Nominalisations.The nominalisations in these abstracts are numerous, and they greatly condense the meanings in their research articles. The following are examples from the text analysis (See next page).

Text I

This paper describes an investigation into "comprehensive" tool wear estimation, including ...

Text II

The performance of the flow control method is evaluated by means of ...

Text III

Bond tests have shown ....

Such nominalisations can condense the meaning which covers the whole or most part of its research article. Take such a nominalisation from Text I. In Text I, there is the nominalisation "investigation". "Investigation", this word sounds very general. An investigation can be any kind of investigation, either formal or informal, technical or non-technical. In this abstract, this nominalisation appears at the beginning. Its purpose is to draw the readers from a generally broad field into later a more specific and technical field. The following is the process of unpacking and analysing how the meanings are condensed into this single word. This word contains the following meanings.

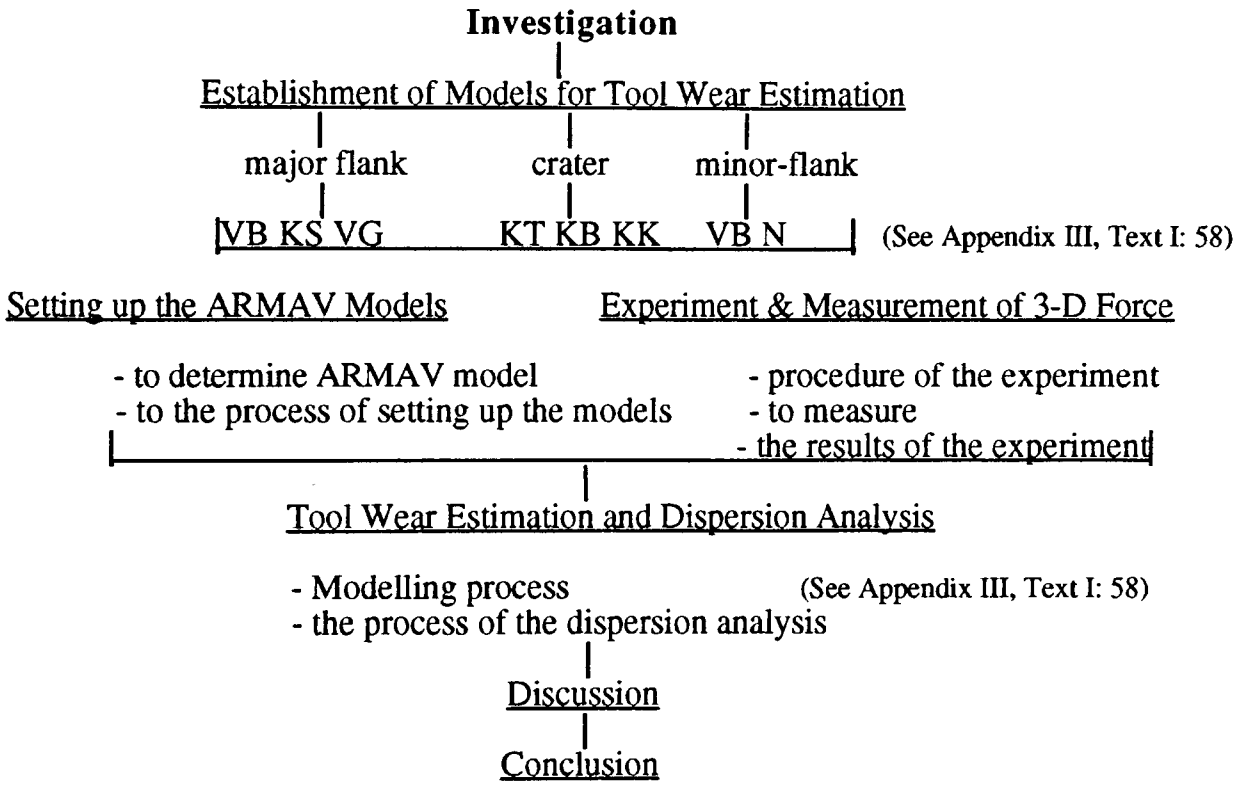
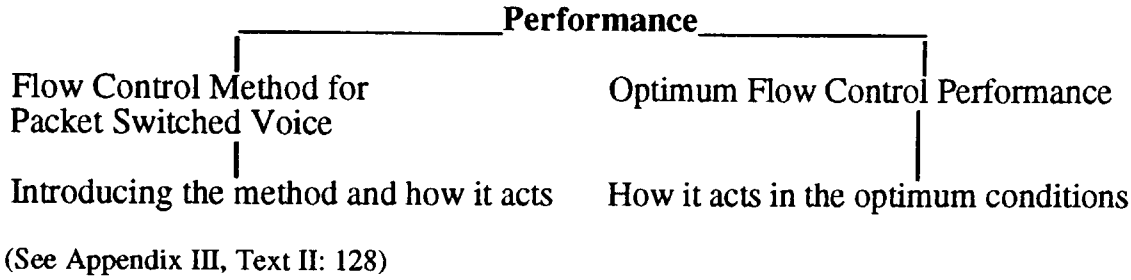


Figure 5. 1: The unpacking of the nominalisation "investigation" in Text I.

As this diagram shows, this investigation covers several steps (the underlined parts) which span from the beginning of the research article to the end. They are: Establishment

of Models for Tool Wear Estimation, Setting up the ARMAV Models, Experiment and Measurement of 3-D Force, Tool Wear Estimation and Dispersion Analysis, Discussion and Conclusion. The second step the Establishment of the models for Tool Wear Estimation has greatly specified the meaning of this "investigation". It brings the general sense into a specific and technical field. The later steps drawn from the diagram have provided more detailed information about this investigation.

Another example is from Text II. In Text II, the nominalisation is "performance". "Performance" is also a kind of generalisation of certain happenings. Again, it can be either technical or non-technical. In Text II, this nominalisation can cover the meanings that run through the two sections of its research article.



(See Appendix III, Text II: 128)

Figure 5. 2: The unpacking of the nominalisation "performance" in Text II.

This nominalisation contains the meanings expressed by the two sections in the research article. The first section introduces this method and how the method performs in the experiment. The second section tells how this method performs in the optimum conditions. As for its specific side, the range it covers is limited by its context, that is, the performance of this flow control method.

Another example is from Text III. The nominalisation "test" still has a very general sense, although it is always linked up with scientific experiments in laboratories. A test can be any kind of test. Inside of its general side, it still has its specific aspect in the text. The tests mentioned in this context of the abstract refer to the ones in the material engineering. Unpacking this nominalisation, it covers the following aspects in the research article (See next page).

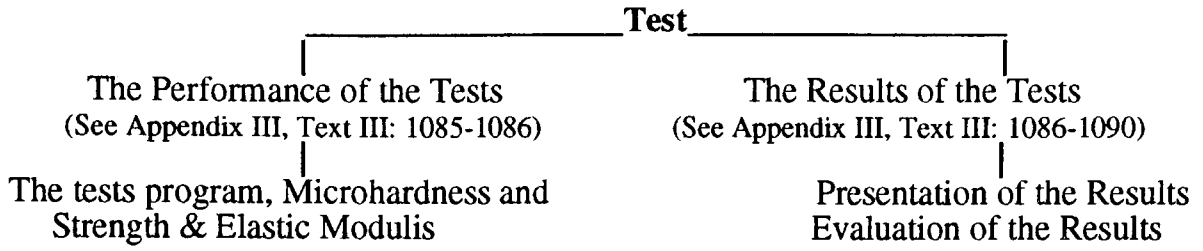


Figure 5. 3: The unpacking of the nominalisation "test" in Text III.

From the analysis of the unpacked meanings of the nominalisations "investigation" "performance" and "tests", it is fascinating to identify the ways in which the meanings have been condensed into these individual words. What is more important is to recognise the significant function of Nominalisation - the key "tool" which has made this condensation of meaning happen. The meaning condensation, in fact, can be regarded as the process of generalising or summarising. The generalisation of different happenings makes a nominalisation flexible enough to be fitted into a vast area of meanings in the research article. In addition, the generalisation process also brings more abstraction. It is because of this abstraction that has made the nominalisations capable of condensing more meanings in different parts of the research article.

Other nominalisations also have such ability as to condense the meanings in the research article. Further analysis is presented in Appendix XIII.

1. 4. Conclusion

The above analysis has shown the realisations of the ideational content of the abstracts at the group level. The purpose is to identify the language features occurred in these abstracts and the functions fulfilled in the process of realising the ideational content.

We have seen that the function of compressing a great deal of information is achieved through the use of highly elaborated nominal groups and through the deployment of grammatical metaphor.

2. Two Types of Complexities: Lexical Density and Grammatical Intricacy

The use of nominal groups and nominalisations also provokes changes and rearrangements in other linguistic elements in these abstracts, such as the Lexical Density and Grammatical Intricacy.

It is claimed that the lexical density is regarded as "a measure of the density of information in any passage text, according to how tightly the lexical items (content words) have been packed into the grammatical structure" (Halliday, 1985 B: 13-37). With the great proportion of nominal groups and nominalisations in these abstracts, an important consequence is that the rate of lexical density is high, and the grammatical intricacy is low.

This part of the chapter will carry the analysis further to identify the language features beyond the group level.

Ravelli (1985: 27) demonstrates that there are two major kinds of complexity found in texts. The complexity of spoken texts lies in their grammatical intricacy, while the complexity of written texts lies in their lexical density.

Halliday characterises the complexity of written language as follow:

"The complexity of the written language is static and dense. ...The highly information-packed, lexically dense passages of writing often tend to be extremely simple in their grammatical structure as far as the organisation of the sentence (clause complex) is concerned".

(Halliday, 1985 B: 87).

What has been stated by Halliday is that the most obvious evidence of written language is the heavy use of lexical items, which is called "Density" by Halliday (Halliday, 1985 B: 63). It is regarded as a kind of complexity in the language (Halliday, 1985 B: 87). According to Halliday, there are two types of complexity in the language. They are syntactic and lexical complexities (Halliday, 1985 B: 87). The former is defined as

"grammatical intricacy" and the latter is "lexical density". The correlation between these two complexities in a written text is that high lexical density accompanies low grammatical intricacy. This can be illustrated by examples from the abstracts which express the two extremes: simple in their sentence structure and complex in the use of the lexis:

1. The properties of concrete containing instant-chilled steel slag (I. C. S.) as aggregate are presented.
2. The flow control method relies on a prediction of the current talking/silence state of all voice stations in the network.

These two types of complexity, the proportion of the lexical density and grammatical intricacy, are also thought to be significant indicators of written language in the work of other researchers. In "Discourse Analysis" written by Gillian Brown and George Yule, the written language feature is described as "written language sentences are generally structured on subject-predicate form..." (G. Brown & G Yule, 1983: 16). What is claimed by Brown and Yule is the grammatical simplicity of the written language.

The indication from Halliday, Brown and Yule is that the syntactic simplicity of the written language results from the complexity of its lexical items. Written texts are "highly information-packed" due to their choice of complex lexis. As the information is fully packed up by the lexical items, they need to be well organised and structured.

If those two examples above are re-examined and analysed in terms of their lexis and structure, the two extremes can be illustrated as follows:

1. The choices of lexis:

Ex. 1. The properties of concrete containing instant-chilled steel slag (I. C. S.)as aggregate are presented.

Ex. 2. The flow control method relies on a prediction of the current talking / silence state of all voice stations in the network.

2. The sentence structure:

Ex. 1. Participant^Process, or Subject^Predicate

Ex. 2 Participant^Process^Participant, or Subject^Predicate (Verb^Object)

In the analysis of the lexis in those examples, it is necessary to note the functions of different words. As you can see, the words underlined reveal the content of the text while the rest play a grammatical role to connect these content words. The words which reveal the content of the text are the lexical items called content words (Halliday, 1985 B). Reading simply the lexical parts of these two examples (the underlined parts), the content of the texts still can be revealed.

Ex. 1. ... properties .. concrete containing instant-chilled steel slag (I. C. S.) .. aggregate ... presented.

Ex. 2. ... flow control method relies .. . prediction .. ... current talking / silence state .. all voice stations .. ... network.

The missing words are the grammatical items which are called functional words (Halliday, 1985 B). Functional words show the grammatical relationships between these content words. However, they do not tell any content meanings of a text.

Ex. 1. The ... of ... as ... are ... .

Ex. 2. The ... on a ... of the ... of ... ... in the ... .

As the content words are omitted, one can hardly understand what these texts are about. In a text, it is the choice of content words that shows the density. The following table is the analysis of the content and functional words in those examples.

	Example 1	Example 2
Words	16	21
Content Words	12	13
Grammatical Items	4	8
%	75%	61%

Table 5. 2: The analysis of content and functional words in the example.

In Example 1, there are sixteen words. It consists of twelve lexical items and four grammatical items. In Example 2, there are twenty-one words among which the grammatical items are eight and thirteen are content words. The high rate of lexical items makes those two pieces of written texts complex.

In general, as the written language is regarded as a "Product" (Ravelli, 1985), it has been well organised and revised before being published. Therefore, syntactically, it should be very simple in its structure. The two examples show that the lexis selected has been carefully organised and revised, hence the syntactic patterns are single clauses as simple as Participant^Process and Participant^Process^Participant.

2. 1. The Concept of Lexical Density

As it is mentioned previously, lexical items, according to Halliday, are content words whose function is to reveal the information in a text. As they are described in Ravelli's study, the function of lexical items is to "embody the ideational content of the message" and to "represent things, happenings, people, places, states, feelings, attitudes and so on" (Ravelli, 1985). In the abstracts, these lexical items expose the ideational content of the message and they have represented qualities, things and happenings.

Example:
In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.

Categorising those representatives of the content of the text, they can be realised, in the grammatical field, by following:

Things: geometric accuracy, surface quality, tool wear.
Happenings: finish-machining, affected by,
Place: the minor flank, nose area.
Manner: adversely

From the table displayed above, there are no lexical items as human participants. The realisations of the happenings are not only verbs or verbal groups, but also nominalisations as well, such as "finish-machining".

In contrast, function words do not have the above abilities to reveal the ideational content of a text. Rather, they reveal the relationships between the content words, such as

pronouns, auxiliary verbs, prepositions and conjunctions (Ravelli, 1985). These words play a role in connecting the messages in a text.

When the lexical items are identified, it is possible to calculate the lexical density. The formula of calculating the lexical density is:

Lexical Density = Lexical Items / Numbers of Clauses

This formula is from Ravelli's study (Ravelli, 1985). When counting the lexical items, they should be counted per clause. It is the number of the clauses that varies a text in different grammatical features. The lexical density of the example above is that the lexical items is 14, and there is only one clause. Therefore, the density is 14.

The analysis of the lexical density in the abstracts will be presented in this section. (See Appendix XI). Before going any further into the analysis result, it is necessary to explain some of the inclusions and exclusions in the text analysis.

Firstly, the titles of each Abstract are counted in the analysis. This is because the title is regarded as a part of a text. Title can be regarded as the major theme or subject of a text.

Secondly, there are two complex verbal groups in Text I, such as "used to develop" and "use to extract". As it is claimed Ravelli's study, in these complex verbal groups, both of these verbs contribute to the ideational meaning, therefore, they are counted as two lexical items (Ravelli, 1985: 47).

Thirdly, the abbreviations in the brackets in Text I and Text III are not counted as lexical items, since these initials are only used as a reminder for the later part of the article. However, the abbreviations in Text III which are not in the brackets are each counted as a single lexical item. This is because each initial represents a lexical item mentioned in the early part of the text.

The analysis result of the lexical items is as follows (See next page):

	Text I	Text II	Text III
Words	166	86	107
Lexical Items	111	62	76
%	67%	72%	71%

Table 5. 3: The analysis of the lexical items in the abstracts.

The table shows that the lexical items in these texts are very dense. In Text I, there are 166 words. The lexical words are 111 which makes up 67%. Text II has 86 words among which 62 are lexical items. The percentage is 72%. Text III has 107 words and 76 are lexical words which makes up 71%. The result indicates that the lexical items predominate in these abstracts. This is referred to by Halliday as "highly information-packed"(Halliday, 1985: 87). The next table shows the results of the lexical density in each abstract.

	Text I	Text II	Text III
Lexical Items	113	65	76
Clause	10	7	7
Lexical Density	11.3	9.3	10.9

Table 5. 4: Analysis of lexical density in the abstracts.

The proportion of lexical density in these abstracts is very high. Usually a low lexical density rate is between 3.5-5.0, closer to that of speech (Jones, Gollin, Drury and Economou, 1989).

The high lexical density in those abstracts demonstrates the weight of information they have loaded in the texts. As each is limited by its word length, the author has to condense the information from the research article. As a result, the density of the lexical items becomes high.

In conclusion, lexical density is a feature of written English caused by the high rate of the nominal groups and nominalisations. In an abstract, where the language should be highly compacked, lexical density should higher than usual. In scientific English, the lexical density may be much higher (Halliday, 1985 B: 13-37).

High lexical density in a written text is accompanied by less "grammatical intricacy" which means there are fewer dependent clauses (Halliday, 1985). The next section is about the analysis of the grammatical intricacy in the abstracts.

2. 2. The Concept of Grammatical Intricacy

Different from lexical density, grammatical intricacy focuses on the number of clauses and the logical development within a clause complex, such as what sort of relationship exists between each clause, and how they are built up logically (Halliday, 1985 A & Ravelli, 1985).

Before discussing grammatical intricacy it is necessary to clarify the notion of clause complex which is a basic grammatical unit in this text analysis. As stated by Halliday:

> ... the notion of 'clause complex' enables is to account in full for the functional organisation of sentences. A sentence will be defined, in fact, as a clause complex.
>
> (Halliday, 1985 A: 193)

There are two kinds of clause complex (Halliday, 1985 A & Ravelli, 1985). They are a single clause complex which only contains one clause per clause complex, and multi-clause complex which means that there are more than one clause per clause complex (Halliday, 1985 A). In a multi-clause complex, there are two perspectives to be considered. One is interdependency (or taxis), the other is logical-semantic relations. The descriptions of these two elements are presented below (See next page):

Grammatical Intricacy: Clause Complex

Vector 1: what kind of clause complex (sentence) each is it ?		**Vector 2:** What is the relationship between Clause ?	
Interdependency--->tactic system		**Logico-semantic system**	
Parataxis:	**Hypotaxis**	**Expansion:** The secondary clause expands the primary clause, by elaborating, extending, enhancing. **Projection:** The secondary clause is projected through primary, which instates it as: locution, an idea.	
Compound Sentence: One element modifies another One is initiating, the continuing.	Complex Sentence: The modifying element is dependent on the modifies One is dependent, the other is dominant.		
Logical structure:	**Logical structure:**	**Paratactic**	**Hypotactic**
Paratactic(Compound) 1, 2, 3, ...	Hypotactic(Complex) α, β, ...	Elaboration: 1 = 2 Extension: 1 + 2 Enhancement: 1 x 2 Locution: 1 "2 Idea: 1 '2	Elaboration: α = β Extension: α + β Enhancement: α x β Locution: α "β Idea: α 'β

Figure 5. 4: Grammatical Intricacy and their notations.

A clause complex contains two Vectors. One is concerned with the tactic system, the other is concerned with the logico-semantic system. The tactic system refers to what kind of clause complex it is. That means whether the clauses within a clause complex are of equal status, or whether one depends on the other. The former relation is called "Parataxis", and the latter is called "Hypotaxis" (Halliday, 1985 A: 193). These clauses are also labelled as "Primary" and "Secondary". In a clause complex with paratactic relations, the primary clause plays a role of initiating, the secondary is continuing. In a clause complex with hypotactic relation, the primary clause is the dominant one, and the secondary is its dependent (Halliday, 1985: 194).

The other vector indicates the relationships between each clause (Halliday, 1985 A). The two major types of the logical relationships between clauses within a clause complex stated by Halliday are "Expansion" and "Projection" (Halliday, 1985 A: 195). In expansion, the secondary clause expands its primary clause by elaborating, extending and enchancing. In projection, the secondary clause is projected through its primary one, which can either be an idea or a locution.

As shown in Ravelli's study, the intricacy of a clause is based on two aspects: firstly, the length of the clause complex; secondly, the depth of the clause complex (Ravelli,

1985:34-35). The "length of clause complex refers to "the number clauses within the clause complex" (Ravelli, 1985). The term "depth" means "the number of layers" in a clause complex, which concerns the description of relationships between each clause in a clause complex. The following examples indicate the length and the depth. The method implemented in these examples is adopted from Ravelli's study (1985). The grammatical intricacy is a simple summation of the length and depth of the complex.

Example 1: α It has been found

+β α that the efficiency of a flat-solar can be increased by 10-15%

x β by forming a regular array air collectors of spherical segments in the duct-side of the absorber plate.

There are three clauses contained in this clause complex, therefore, the length is three. The layer of relationships between these three clauses is only two, meaning that the depth is two. The grammatical intricacy is, therefore, three.

Example 2: (Halliday, 1985 A: 195)

-- 1 α I would

-- x β if I could,

-- x 2 but I can't.

In this example, there are three clauses which means the length of the clause complex is three. There two layers, meaning the depth is two. Therefore, the grammatical intricacy is five.

As for an analysis of grammatical intricacy in a whole text, "a summation of the greatest length of any clause complex and the greatest depth of any clause complex is taken as the measure of intricacy is the text" (Ravelli, 1985: 36).

From the descriptions of the grammatical intricacy system, the greatest length and depth of the abstracts are first analysed. This analysis can provide a general impression of the grammatical intricacy in these abstracts.

The analysis of grammatical intricacy is shown at the back of this thesis (See Appendix XII). Again, there are some exclusions in the analysis.

The notations used in this analysis follow what have been indicated in Halliday "Introduction to Functional Grammar" (Halliday, 1985 A: 196-197).

‖	Clause complex boundary
|	Clause boundary

Other notations are illustrated in the early part of this chapter (See Diagram 4.5). The embedded clauses, embedded phrases and enclosed clauses will not be analysed in this section, as they have been included in the analysis of the nominal groups.

In the analysis, the embedded elements are not counted as a single clause. Instead, they are regarded as part of a Participant or any element they refer to.

From the analysis (Appendix XII), it can be seen that the majority of sentences consist of single clauses. There are a few clause complexes consisting of two clauses, and a single instance of a clause complex consisting of 3 clauses (Text I, Sentence 5).

In terms of length, the clause complexes tend to be very short, and in terms of depth, the layering is minimal. We could therefore say that grammatical intricacy of these texts lies at the "most written" end of the mode continuum.

The cause of the low grammatical intricacy is that many of the expressions involve grammatical metaphor, which will be discussed in the following section.

2. 3. Grammatical Metaphor

The previous chapter discusses one kind of grammatical metaphor in these abstracts - nominalisations. Besides the nominalisations in these abstracts, there are other types of grammatical metaphor. This section will look at these types of grammatical metaphor.

Grammatical metaphor function at the interface between semantics and lexicogrammar. For anything meaningful, there will be one or more than one, congruent or metaphorical, realisation in the lexicogrammar (Halliday, 1985 A: 321). In other words, there are different choices available in the lexicogrammar to realise semantic meaning. These choices, although they are different in forms, have some similarities in meaning (Ravelli, 1985). Comparing the following examples, the similarities and differences will be revealed.

1. He has been worried so much because he lost his passport.
2. The loss of his passport has made him greatly worried.

The meaning in the social context expressed by these two examples is similar. However, they demonstrate two different linguistic realisations. In the first example, the action or the doing is realised by a Material Process "lost". The logical connection of cause and effect between these two clauses is shown quite clearly by the conjunction "because". Therefore, because - the explicit expression of cause and effect in this example can be seen as more congruent. In contrast, the second example gives a different interpretation. The realisation of the action or the doing is nominalised, acting as a Thing in the nominal group, as the following diagram shows.

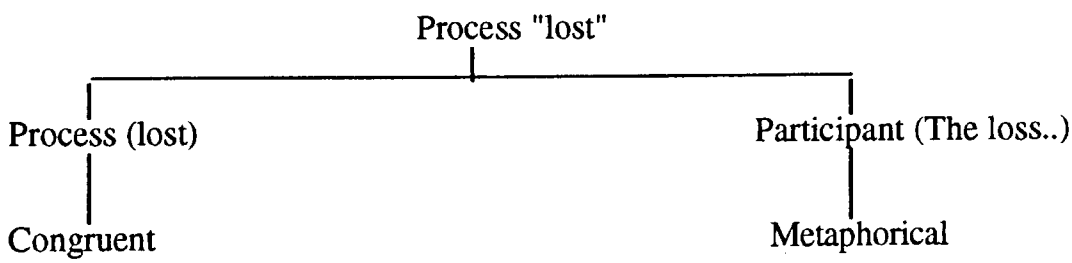


Figure 5. 5: The realisations of the word "lost".

The relationship of causality now resides in the verbal groups, "has made".

In this section, the intention is to draw attention to the ways in which grammatical metaphors are used in these abstracts, what the consequences are, and the functions which these grammatical metaphors serve.

There are different types of grammatical metaphor in the language system. In Ravelli's study, there are different categorises of grammatical metaphor which have been identified.

No.	Semantic Choice	Metaphorical Realisation	Congruent Forms
1a.	material process	Thing / nominal group	verbal group
1b.	mental process	Thing / nominal group	verbal group
1c.	relational process	Thing / nominal group	verbal group
1d.	verbal process	Thing / nominal group	verbal group
1e.	behavioural process	Thing / nominal group	verbal group
2.	process	Epithet, Classifier / adjective	verbal group
3a.	quality of a Thing	Thing / nominal group	adjective
3b.	quality of a process	Epithet, Classifier / adjective	adverb
3c.	quality of a process	Thing / nominal group	adverb
4a.	modality	Epithet / adjective	(modal) adverb
4b.	modality, modulation	Thing / nominal group	adjective, passive verb
5a.	logical connection	Thing / nominal group	conjunction
5b.	logical connection	Process / verbal group	conjunction
6.	circumstance	Process / verbal group	prepositional phrase
7a.	participant	Classifier / adjective	nominal group
7b.	participant	Thing / nominal group	nominal group
8a.	expansion	Act, Relative/embedded Clause	ranking clause
8b.	projection	Fact / embedded clause	ranking clause
9.	circumstance	Epithet, Classifier / adjective	prepositional phrase

Table 5. 5: Categories of grammatical metaphor (Ravelli, 1985).

In category 1, the actual doings or actions which have a process meaning are realised by the metaphorical form: a Thing.

Category 1 is the most commonly used in these abstracts. The result of the analysis of the grammatical metaphor in these abstracts shows that most of the metaphorical forms tend to be nominalisations among which most of them are converted from Process in congruent forms into a Thing in metaphorical expression (See Appendix XIII). Text I has 18 nominalisations, excluding the repetition ones. Sixteen out of eighteen are shifted from actual doings or actions in congruent form, making up 89%. Text II has seventeen nominalisations, not including the repetitions ones. 88% is nominalised from the Processes in Category 1. Text III has seven nominalisations among which 86% is converted from the Processes mention in Category 1.

Further more, most of these nominalisations are converted from Material Process which expresses the actions and doings. This is shown below.

	Text I (16)	Text II (15)	Text III (6)
Material Process	13	11	6
Mental Process	1	3	0
Relational Process	1	0	0
Verbal Process	0	1	0
Behavioural Process	0	0	0

Table 5. 6: The nominalisations of different types of processes.

As we have seen in the previous chapter, the abstracts contain many examples of this, eg:

the network utilisation

"comprehensive" tool wear estimation

station's transmission capacity

the current talking

No examples of behavioural metaphors were found in the texts, since there is not human Participant in the abstracts.

Category 2 reveals that the actual happenings or the Processes are realised by elements in nominal groups, such as Epithets or Classifiers.

Category 2 deals with the different realisations to realise the semantic meanings of process in the reality. In congruent form, the realisation should be verbs or verbal groups, but in the metaphorical form, they can be Epithet, Classifier or adjective. When a process can be turned into an Epithet or a Classifier depends on whether it is in passive or active voice and the tenses it refers to. As it is claimed by Halliday:

When functioning as an Epithet, these forms usually have the sense of the finite tense to which they are most closely related: the present participle means 'which is (was/will be) ...ing', the past participle means 'which has (had/will have) been ...ed'. When functioning as Classifier, they typically have the sense of a simple present, active or passive: present (=active) 'which ...s'. past (=passive) 'which is ...ed".
(Halliday, 1985 A: 164)

The examples of this are listed below:

the cutting force

packet switched voice

As it is shown in the above examples, "the cutting force", from Text I can be glossed as "the force which cuts", which is in the active voice. The other example, "packet switched voice", from Text II, can be glossed as "packet voice which is switched", which is in the passive voice.

Category 3 illustrates how the quality of a Thing can be realised by lexicogrammatical items other than the congruent adjective:

the tensile splitting strength

The existence of Category 3 depends on the previous categories. Many Processes are nominalised metaphorically in the written language. As a consequence of that, the congruent forms of the verbal groups and adverbs which qualify the Processes will be changed so as to qualify the Things.

Category 4 deals with the ways in which modality is not realised by a modal verb, but rather by an Epithet or a Thing. An example is:

transmission capacity

Category 5 shows the metaphorical realisations of logical connections which should be realised by conjunctions in the congruent form.

The results show that...

Category 6 shows the metaphorical expressions of circumstances whose realisations in congruent forms should be prepositional phrases. There is not such an example in these three texts.

Category 7 shows the realisations of Participants as Classifiers. The following is the examples (See next page):

voice station

an optimum condition of the network utilisation

Category 8 concerns the realisations of ranking clauses in congruent form which are expressed through embedded elements. An example is shown as follows:

an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.

As the analysis of the grammatical intricacy shows above, the syntax of the texts tends to be simple, as a result of the embeddings. There is no projections in these texts. Therefore, it is not discussed here.

Category 9 refers to how circumstance are realised as Epithets or Classifiers rather than prepositional phrases:

eg. the current talking /silence state

on-line tool wear monitoring

surface quality

interfacial bond splitting strength

2. 4. The Summary of the Relationship between the Lexical Density, Grammatical Intricacy and Grammatical Metaphor

The above discussion about these three concepts in written language and the analysis of the texts reveals the close relationship between lexical density, grammatical intricacy and grammatical metaphor. The analysis of the three abstracts illustrates that the proportion of lexical density, grammatical metaphor and grammatical intricacy is as following (See next page):

Low Lexical Density---------->High
Low <----------Grammatical Intricacy High
Low Grammatical Metaphor-------->High

Figure 5. 6: The proportion of lexical density, grammatical intricacy and grammatical metaphor.

The high lexical density can show the ideational content of the texts so that they can provide as much information as possible for the reader to know what actually the thesis or paper is about without reading the source texts. The high lexical density is compounded by grammatical metaphor. As a result, the grammatical intricacy is low. These abstracts demonstrate Halliday's contention that written texts will exhibit complexity in terms of lexical density, whereas the complexity of spoken texts lies in their grammatical intricacy.

3. Conclusion

The above analysis has shown the lexicogrammatical realisations of the ideational content of the abstracts both at the group level and below the group level. The intention of the analysis is to identify the language features characteristic of abstracts and the functions of such features. The high rate of nominal groups and nominalisations, resulted in high lexical density and low grammatical intricacy. The characteristics of the language features can be summarised as highly metaphorical and fully information-packed.

Firstly, most of the Participants are non-human Participants which reveal the generic nature of the abstracts. Some of the Participants are metaphorised, playing roles as "human" Participants in the texts. This makes the abstracts impersonal and metaphorical.

Secondly, the Participants and the Circumstances in these abstracts are mostly very long nominal groups. The function of these nominal groups is to specify a phenomenon in great detail and to reveal the relationships between each individual element, eg. "a type of" or "a part of".

Thirdly, as these abstracts are limited by their word length, they need to be efficient and concise. To meet this demand, nominalisations are the most important tools. The function

of the nominalisations is to "thingise" the actual happenings and to condense the meanings. As the analysis shows, nominalisations are frequently used in these abstracts. With those two functions of the nominalisations, the abstracts are heavily information-packed.

As a consequence of the nominal groups and nominalisations, other features of the text are influenced. These are the aspects of lexical density, grammatical intricacy and grammatical metaphor. In the written mode, these three aspects have correlated with each other, the high level of lexical density and grammatical metaphor correlating with the low level of grammatical intricacy.

Chapter 6

Conclusion and Discussions

In the previous chapters, different characteristics of abstracts are discussed in terms of the genre and its schematic structure, linguistic features and their functions at text level, the clause level and the group level. This chapter will conclude the previous analysis of the abstracts and discuss the problems and limitations of this study.

1. Genre and Schematic Structure

The purpose of the analysis of genre and the schematic structure is to provide an overview of the abstracts. Because the genre influences other language features in a text, identifying the genre of a text makes it easier to identify what other typical features we might expect to find. In respect of the analysis at text level, the analysis follows the schematic structure which has been developed by Martin and Peters (1985). This part of the analysis shows the different stages of texts, and how the stages shift from one to another in order to realise the purpose of the abstracts.

As the analysis shows, it can be seen that these abstracts do not fit any of the specific genres demonstrated in Martin's work (Martin, 1985). Instead, they reflect the generic structure of their source article, in this case accounts of engineering experiments. All the abstracts display similar elements in their schematic structure - establishing the problem/area to be researched, recounting the experiment, and reporting the results. The

abstracts tend to shift between general, abstract principles and the specific detail of a particular sequence of events.

We could summarise the schematic structure of this type of abstracts as follow:

Beginning:
To state the research problem.

Middle:
To introduce the methods involved in the research and to provide a chronological recount of the experiment.

End:
To announce the experiment results.

2. The Analysis of the Genre and Register

Following the analysis of the genre of the abstracts, the abstracts have been analysed at the clause level. The purpose was to discover how genre and register work together, such as how genre and field, and genre and mode work together.

2. 1. Genre and Field

In the analysis of the clause level, the analysis of transitivity shows two characteristics of the participants in these abstracts: generic classes and metaphorical.

Due to the genre of the abstracts, impersonality is the most important feature of these abstracts (Martin, 1985). As a consequence of that, the Participants are required to be non-human and belonging to generic classes. Using passive voice contributes to the impersonality. In the analysis, it has been demonstrated that most of the Participants helped to specify a particular, specialised field of engineering. The other characteristic is use of metaphorical Participants, which act as Actors in the abstracts.

The major Processes used is these abstracts are Material Processes and Relational Processes. As stated, genre influences the types of process (Martin, 1985 & Jones, Gollin, Drury and Economou, 1989). In exposition genre, Material Processes, Relational Processes and Mental Processes are mostly used. Their function is mainly to establish the thesis for the text. In Text I and III, these processes can be found while in Text II, only Material Processes are used.

2. 2. Genre and the Textual Features

Texture is another variable of the register in a text. In this part of the analysis, some textual features are examined.

First of all, the Theme and Rheme are analysed in these abstracts. From the analysis, it is seen that most of the Themes in these abstracts are impersonal ones. This is brought about by the use of generic and metaphorical Participants and the use of the passive voice in these texts. Most of the Themes tend to be very long and contain a great deal of information. There are not many Textual Themes and Marked Themes in these abstracts. As for the organisation of information in these abstracts, it has been shown that the first theme in the abstract is very important since it reveals the problem or the general orientation of the abstracts. The organisation of the later Themes and Rhemes are based on the prior Themes or Rhemes. They do not have a fixed pattern in any of the texts.

Besides the analysis of Theme and Rheme, the cohesion of the texts is also analysed. The purpose is to reveal the cohesive relationships between clauses within the texts. The cohesive elements are Reference, Ellipsis and Substitution, Conjunction and Lexical Cohesion.

The analysis of reference illustrates that there is not any personal reference in these abstracts. In Text III, there are three comparative reference elements. For the rest, most of the cohesive items are endophoric reference, many of which are cataphoric.

As for ellipsis and substitution, they are not widely used in these abstracts at all. This might be explained by the fact that these abstracts are fully information packed. Ellipsis and substitution are only used when least misunderstanding can be caused.

The conjunctions in these abstracts are mostly implicit ones. As the analysis of Theme and Rheme shows, there are not many Textual Themes in these abstracts. Correspondingly, there are not many explicit conjunctions.

The lexical cohesion analysis in these abstracts shows that the lexical items cluster into two or three major strings. As the relations between the cohesive elements indicate, most of the relations are hyponemic, building up class/sub-class taxonomies and meronymic, building up part-whole taxonomies.

3. The Language features below the Clause Level

Following the analysis of the abstracts at the text and clause level, the later chapter has carried the analysis further below the clause level. The purpose is to reveal what the language features and the functions are behind these texts and clauses. The basic unit in this part of the analysis is the group.

Nominal groups and nominalisations are the major language features in this part of the analysis. It is stated that one of the tasks which language fulfils is the ordering of reality. The tool used to fulfil this task is the nominal group. The nominal groups and nominalisations are the realisations of the ideational content of the texts at the group level.

The previous analysis of the Participants shows that most of the Participants are generic and metaphorical ones.

It has been shown that the abstracts exploit fully the resources of the nominal group. These nominal groups have specified the thing or phenomenon with the Deictic, Numerative, Epithet, Classifier, Thing and Modifier. Through linguistic elements such as Deictic, Classifier and so on, the technical field is also built up. It is demonstrated in the analysis that most of the technical terms are formed as Classifier^Thing.

The use of nominalisations in these abstracts function to condense the meanings, to distance the reader and the writer. Because each abstract is limited by its word length, efficient, clear and full expressions of the meaning are required. To achieve this meaning condensation, nominalisation is the best language tool. The analysis shows how the meaning is condensed by these nominalisations. The broad nominalisations in Text I and II condense almost the whole meanings covered in the research articles. In addition to the function of meaning condensation, the nominalsations can also distance the reader by making the language metaphorical and impersonal. In this process, a happening in real human Participants is converted into an abstract phenomenon.

The great proportion of lengthy nominal groups and nominalisations also cause other language features. For example, it has resulted in the high lexical density of these abstracts and the corresponding low grammatical intricacy. The analysis also shows that various types of grammatical metaphor are found in these texts.The characteristic language features exemplified in these abstracts can be summarised by the diagram below:

Abstract (See next page):

Genre

Schematic Structure

Beginning	Middle	Ending
To state the problem or to give orientation to the reader	To introduce the methods and procedure of what is done	To show the experiment results in order to give a summary.

Figure 6. 1: Summary of the schematic structure of the abstracts.

Language Features and the Function:

Clause Level	Text Level	Beyond Clause Level
Participants are generic and metaphorical. mostly timeless Material and Relational ones. Themes are impersonal and experiential. Not many Textual or Marked Themes.	Cohesive items are Cataphoric Reference. Not much Ellipsis and Substitution. Not many explicit conjunctions. Lexical Cohesion in limited strings.	High frequency of long nominal groups and nominalisation. High Lexical Density and Grammatical Metaphor.

Figure 6. 2: Summary of the language features in the abstracts.

4. Limitations of the Analysis

There are many limitations in this analysis in terms of the number of texts analysed, the range of fields and the variety of analyses. In terms of the number, there are only three abstracts analysed in this study. As claimed previously, the intention of this study was to understand a preliminary analysis to identify typical features of this particular type of abstract.Further research would need to be undertaken to confirm these features in a larger sample of texts and identify features of other types of abstracts.

Although the abstracts cover different fields, they still belong to the same discourse of science and technology. Even in this science and technology field, these abstracts all deal with one branch of the field - engineering. Therefore, the area is quite limited. Other areas, such as social science, are not included.

The analytical tools in this text analysis are based on Systemic Functional Grammar. This is because this grammar has been found to be very effective in combining the functions of the language and its forms. Hence this grammar has been used as the theoretical

framework in this study. It does not mean that other types of grammar could not be used for such a kind of analysis. There might be equally effective ways to look at these abstracts using different analytic tools.

5. Recommendations

Due to the limitations of this study, there is no way to make a generalisation regarding the abstract writing in any other area. What should be recommended from this study is that abstract writing needs further studies and analysis. From the results of other studies discussed in the literature review, it can be seen that making the features of academic writing explicit is very effective in the terms of assisting language learners. Hopefully, abstract writing should be made as simple and explicit as other academic writing. Obviously, the achievement of this purpose will require more studies and research in this area.

THE END

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Appendix I

The Overview of the Abstract

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

Abstract

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining. The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on these, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear. The results show that minor flank wear reaches a critical value first in finish-machining, so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear. The results also show that the method is a feasible means for on-line tool wear monitoring in finish-machining.

Appendix I

The Overview of the Abstract

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

A flow control strategy for packet switched voice is introduced and described in this paper. It is designed in such a way as to achieve an optimum network utilisation and speech quality. The performance of the flow control method is evaluated by means of a simulation study.

The flow control method relies on a prediction of the current talking/silence state of all voice stations on the network. A strategy for predicting the network traffic load and two methods of calculating each station's speeach rate, are simulated.

Appendix I

The Overview of the Abstract

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Abstract

The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented. The I.C.S. slag possesses good physical and mechanical properties and has sufficient stability for use as a coarse aggregate in concrete. Bond tests have shown that I.C.S.slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate. The tensile splitting strength of the slag aggregate itself is higher than that of limestone. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate.

Appendix II

The Survey Notes

In 1991, the present researcher had survey so as to see the results of the application of the Systemic Functional Grammar (SFG) to assisting overseas students' writing at the tertiary level. The followings are the survey sheet, the materials from the institutions which draw on SFG in their student support programs, and the results from the survey.

The Outline of the Survey

How overseas students support service are utilising Systemic Functional Grammar

I. The content of the report

This report is on the nature of the language support available to the overseas students in N.S.W. Tertiary institutions, in particular those drawing on SFG.

II. The purpose of the study

The purpose of the report is to document how the SFG is utilised in these places in order to support the overseas students to learn English and in what aspects the SFG is used to serve the overseas students. Ultimately, the information gained from this research will contribute to the researcher's minor thesis which will be examine the use of SFG in overseas students' essays.

IV. The procedure of the study

In doing this, the following data will be collected from the N.S.W. Tertiary institutions.
------ teaching materials
------ course outlines
------ policies
------ observations
------ interviews - Helen etc. (Through Helen, the researcher may get to know other people at UTS, NSW, SU--EMOS, Macqurie University.)
After collecting those data, the researcher will analyse them and report on her findings from the interviews with the people who work in this area and any proposals they might suggest for the further research.

V. The interview questions

1. When did you start to use SFG in supporting students' learning ?

2. What have you found the most useful aspects of SFG? Is there any area that SFG is not helpful ?

3. How do you teach the students to use the functional grammar in their essay writing ?
   Is it a tutoring or are the students actually taught SFG?

4. If the student are taught SFG, do they find it helpful?

5. Having taught SFG for a period of time, what do you think of the functional grammar ?

6. How is SFG evaluated the effect on students' language?

7. Do you think the functional grammar can be an alternative to Traditional Grammar ?

8.What do you do when you have a student who knows the rules of the language very well but does not know how to use them to express himself/her self in a way which is culturally appropriate or academically acceptable?

Do you have any suggestions for me to read and any materials about the present research done by other people in this area.

Survey Sheet

The purpose of the survey is to document the utilisation of Systemic of Functional Grammar in supporting overseas students' essay writing. The researcher is interested in finding out what aspects of SFG are used to serve overseas students. Ultimately, the information gained from this research will contribute to the researcher's minor thesis which will examine the use of SFG in assisting overseas students with their essay writing.

1. When did you start to use SFG in supporting students' learning ?

a. two years b. five years c. more than five years

2. What have you found to be the most useful aspects of grammatical features of SFG?

3. a. Do you teach the students the aspects of functional grammar for use in their essay writing?

b. Which aspects do you think they find useful ?

4. a. Do you draw on your knowledge of SFG when tutoring, without teaching it to the students ?

b. Which aspects do you draw upon most frequently ?

5. Do you think the efforts spent teaching the SFG pay sufficient dividends in the students' written work ?

6. Do you have any evidence that SFG helps students improve their writing/studies ?

How is this evaluated ?

7. a. Do you think the functional grammar serves as an alternative to Traditional Grammar?

a. Yes b. in some aspects of language learning c. no

b. If students already are familiar with Traditional Grammar, can SFG provide any greater assistance in area where overseas students commonly have problems, eg.

-idiomatic expressions

- "odd-sounding" syntax

- irregularities in use of prepositions

- agreement between the Subject and verb

- omission of Subject

- irregular verb formation

- any other problems

8. What do you do when you have a student who knows the rules of the language very well but does not know how to use them to express himself/herself in a way which is culturally appropriate or academically acceptable?

9. Please list any materials which you use which utilise SFG ? Are these publicly available ? If so, where can they be obtained ?

10. Can you recommend any background readings in SFG/ESP/EAP which you have found useful ?

Survey Sheet
(Results)

1. When did you start to use SFG in supporting students' learning ?

a. two years b. five years c. more than five years

For the institutions which draw on SFG, they all have more than five years experience in utilising SFG in supporting the overseas students' learning.

2. What have you found to be the most useful aspects of grammatical features of SFG?

It depends on what level, what purpose, and what problems the students have in their essay writing. Usually the Genre and Theme/Rheme, grammatical metaphors, conjunctions and the schematic structure are quite important aspects.

3. a. Do you teach the students the aspects of functional grammar for use in their essay writing?

It depends on what the level the students are. Most of the time, analysis of texts are the main purpose for the students to know. Sometimes, the students are taught about the functional grammar so that they can use it to help themselves in their essay writing.

b. Which aspects do you think they find useful ?

Genre theories, Theme and Rheme and the cohesions (cohesive ties) are very useful.

4. a. Do you draw on your knowledge of SFG when tutoring, without teaching it to the students ?

The answer to this question is almost "Yes".

b. Which aspects do you draw upon most frequently ?

Genres, schematic structures and Theme and Rheme.

5. Do you think the efforts spent teaching the SFG pay sufficient dividends in the students' written work ?

Most of the interviewees are the strong followers of the SFG.

6. Do you have any evidence that SFG helps students improve their writing/studies ?

How is this evaluated ?

Although there is not any official evaluations or evidence to show the achievements of the utilisation of SFG, from the students' work, it can be seen that SFG is much helpful to the improvements of the students' essays.

7. a. Do you think the functional grammar serves as an alternative to Traditional Grammar?

The answers to this question are different. Some people think that SFG is an alternative to Traditional Grammar. The followings are the reasons why they think so.

When talking to the students about their essay writing and the analysis of their own essays, the Traditional Grammar is useless. And the functional grammar is functional so that it helps students.

However, some people think that in some aspects SFG can be an alternative to Traditional Grammar. It is because SFG is built on the basic understanding of the Traditional Grammar.

b. If students already are familiar with Traditional Grammar, can SFG provide any greater assistance in area where overseas students commonly have problems, eg.

- *idiomatic expressions
- *"odd-sounding" syntax
- *irregularities in use of prepositions
- *agreement between the Subject and verb
- *omission of Subject
- *irregular verb formation
- any other problems

Most people think SFG is helpful in those aspects (See the sign "*").

8. What do you do when you have a student who knows the rules of the language very well but does not know how to use them to express himself/herself in a way which is culturally appropriate or academically acceptable?

Usually, they build up the functional grammar on their own knowledge. Some old terms are still used, such as, the subject, predicate, the objects and so on. On the basis of the knowledge of Traditional Grammar, the new terms are still introduced to such students. Actually, it is very good that they have already have some basic ideas about the grammar. The students pick up very quickly, because they have already have basic knowledge about the grammar.

Most people think that it is a good starting point if a student has some basic knowledge about the Traditional Grammar. He/she can find how the SFG relates to the Traditional Grammar.

9. Please list any materials which you use which utilise SFG ? Are these publicly available ? If so, where can they be obtained ?

The readings recommended are mostly listed in the Reference part of this thesis.

10. Can you recommend any background readings in SFG/ESP/EAP which you have found useful ?

As above.

Appendix III

The Research Article

Text I

Comprehensive Tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

Comprehensive Tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

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Received on January 15, 1990

ABSTRACT

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining. The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on these, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear. The results show that minor flank wear reaches a critical value first in finish-machining, so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear. The results also show that the method is a feasible means for on-line tool wear monitoring in finish-machining.

KEY WORDS: Multivariate Time-Series, Tool Wear, Dispersion Analysis, Finish-Machining, Minor Flank Wear, Nose Wear.

1. INTRODUCTION

The necessity of effective tool wear estimation in real-time has been recognized in relation to the needs of adaptive control and efficient tool change policy. Reported work has been concentrated on the estimation of flank wear [9,10,19] and some on flank and crater wear combined [1,7].

In operations such as a finish-turning of a bar, however, wear of the minor flank and nose plays a vital role in assuring the geometric accuracy and surface integrity of the finished product. It is obviously desirable for these wear states to be effectively monitored as well, because it is likely that wear in these areas may reach critical points earlier than those in the flank and crater, such that the optimum cutting conditions or tool change policy in a finish-operation have to be set based on these wear types. Therefore, a more comprehensive monitoring strategy involving multi-sensor or multi-modeling is called for.

Employing multi-sensor or multi-modeling strategies has been identified in a recent survey conducted for CIRP [17] as one of the three promising directions in machining process monitoring and control research. Interesting work has been reported in integrating force and acoustic emission (AE) signals via neural networks [14]. Chryssolouris [2] evaluated the effectiveness of sensor integration for tool wear estimation by neural network, least-squares regression, and the group method of data handling (GMDH) algorithm using simulation data. Both papers reported better estimation of flank wear by integrating multi-sensory information than by using a single sensor. For finish-machining where more than one quantity is to be estimated, however, a multi-sensor and multi-modeling strategy as suggested in [17] becomes necessary.

The "comprehensive" monitoring strategy has been addressed less frequently, perhaps because of the complexity of the machining process. If more than one quantity is to be estimated, more complexity will be encountered. This places higher demands on signal processing and analysis techniques which shall be able to "single out" from the signals particular ingredients sensitive to particular quantities to be estimated. Otherwise, multi-sensory techniques will do more harm than help. The spectrum analysis is a technique commonly used to single out frequency components to be correlated to tool wear [3,8,15]. Time domain methods, such as using autocorrelation coefficients of cutting force signals have been reported [19]. It, however, has been recognized that the cutting process is a stochastic process due to the existence of inevitable material property variations and other uncertainties. The necessity of employing stochastic analysis for cutting dynamics was emphasized in [6]. Interesting work on correlating coefficients of Autoregressive (AR) models of AE signals to the flank wear was reported [9], though appreciation of the results is impaired by inadequate physical interpretations. Another example of using stochastic analysis is to detect tool breakage by monitoring the residuals of an AR model obtained from cutting torque signals [16]. The residual analysis has been proven to be very effective to detect abrupt changes in the cutting process, such as tool breakage.

This paper describes an investigation into a comprehensive estimation strategy, including the rate of flank, crater, minor flank and nose wear, for oblique finish-turning operations of a bar. The estimation is based on the cutting force measured in terms of its three orthogonal components, from which trivariate Autoregressive Moving Average Vector (ARMAV) models [11] were developed. The dispersion analysis (DA) based on the ARMAV models [4,5] led to the discrimination between various modes of force variations in a quantitative way, such that correlating them to various quantities to be estimated was made possible. The correlation results were supported by physical interpretations.

2. TRIVARIATE ARMAV TIME SERIES MODELS FOR TOOL WEAR ESTIMATION

It is known that the dynamic cutting force, which is the variation from the average cutting force, contains richer information about tool/workpiece interactions during machining than the latter alone [6]. It has been shown that the dynamic cutting force is a stochastic signal which roughly obeys the normal distribution [18]. It is also appropriate to regard the dynamic force as stationary processes at different stages of wear development, because it takes only a fraction of a second for a set of a few hundred data points to be sampled each time. In summary, it is appropriate to apply statistical methods for stationary normal processes to the dynamic cutting force signal. As a way of analyzing the dynamics in the cutting force measurements, trivariate time series models, developed from the data, are used, since they give a concise parametric representation of the signals.

When a dynamic cutting force represented by its three orthogonal components is sampled at uniform intervals, Δ, the resulting discrete series of observation vectors; X_t, t=1, 2, ..., N; can be represented by

$$X_t = \sum_{i=1}^{n} \phi_i X_{t-i} + a_t - \sum_{i=1}^{m} \theta_i a_{t-i} \qquad (1)$$

where the 3-dimensional vector of process variables is given by $X_t = [X_{1t}, X_{2t}, X_{3t}]^T$, $a_t = [a_{1t}, a_{2t}, a_{3t}]^T$, and $E[a_t a_{t-k}^T] = \delta_k \sigma_a$. Superscript T denotes vector transpose, E expectation, δ_k the Kronecker delta function, σ_a the covariance of a_t.

The model in Eq.1 is termed as Autoregressive Moving Average Vector model of autoregressive order n and moving average order m denoted by ARMAV(n,m). Such a model expresses the observed trivariate series, $X_{1t} = F_{xt}$ = feed force, $X_{2t} = F_{yt}$ = thrust force, and $X_{3t} = F_{zt}$ = main cutting force, as linear combinations of past observation vectors and independent random vectors a_t. The parameter matrices ϕ_i's and θ_i's are estimated based on the observation vectors and therefore describe instantaneous dynamics of the cutting process. The orders of an adequate model can be determined by the F-test or by examining the correlations of the independent random vectors a_t [11].

Once an adequate ARMAV model is determined, the Dispersion Analysis (DA) is carried out as follows. The characteristic parameter matrices, ϕ_i's, of the time series model given by Eq.1 are adjoined so that

$$T \Lambda T^{-1} = \begin{bmatrix} \phi_1 & \phi_2 & \cdots & \cdots & \phi_n \\ I & 0 & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & 0 & I & 0 \end{bmatrix} \qquad (2)$$

where Λ is a matrix of eigenvalues and T the eigenvectors. It can be shown [11] that the correlation matrix of the measured variables is a weighted linear combination of the eigenvalues, λ_i, i=1,2, ..., 3n, as follows

$$\gamma_k = E[X_t X_{t-k}^T] = \sum_{i=1}^{3n} d_i \lambda_i^k \qquad (3)$$

If k = 0, one obtains the covariance or dispersion matrix for the measured variables as

$$\gamma_0 = E[X_t X_t^T] = \sum_{i=1}^{3n} d_i \qquad (4)$$

where d_i is the dispersion associated with eigenvalue λ_i and given by

$$d_i = \sum_{j=1}^{3n} \frac{g_i \sigma_a g_j^T}{1 - \lambda_i \lambda_j} \qquad (5)$$

and g_i the products of submatrices of T and T^{-1}.

The significance of Eq.4 lies in the fact that the process variation γ_0 is decomposed into contributions of process eigenvalues in terms of dispersion d_i's quantitatively. Of particular interest are the d_i's associated with eigenvalues occurring in complex conjugate pairs which contribute to the oscillating or periodical variation of the process. The frequency corresponding to a pair of complex conjugate eigenvalues is given by

$$f_i(\text{Hz}) = \frac{1}{2\pi\Delta} \tan^{-1}(\text{Im}(\lambda_i) / \text{Re}(\lambda_i)) \qquad (6)$$

where Δ is the sample interval in seconds. By decomposing the process variation γ_0 into dispersion d_i's which correspond to eigenvalues and ultimately correspond to frequencies, an order of merit of the existing frequencies (oscillating modes)

can be established such that analysis and interpretation in terms of physical phenomena, such as natural frequencies of the tool/tool holder system and machine tool structural frequencies can be carried out in a quantitative manner.

3. EXPERIMENTS AND TOOL WEAR MEASUREMENTS

3.1 Description of Experiments

The tool wear experiments were carried out using a dynamometer (KISTLER Type 9257A). Table 1 gives the machining conditions used in the experiments.

Table 1 Machining Conditions Used in Tool Wear Experiments

Machine Tool	Colchester Mascot 1600 (9.3 KW)
Tool Insert Type	TNMA160408F (Carbide)
Tool Geometry	Rake Angle 0°, Inclination Angle -6°, Relief Angle 5°, Cutting Edge Angle 0°
Work Material	AISI4140 (HBN=275-320)
Workpiece Dimension	Length =1m and Diameter =100mm
Cutting Conditions	Group 1 : V=115m/min f=0.1mm/rev d=0.5mm Group 2 : V=145m/min f=0.1mm/rev d=0.5mm Group 3 : V=145m/min f=0.06mm/rev d=0.5mm
Cutting Fluid	No

To assure the experimental conditions being as close as possible to practical machining operations, the machining process was interrupted periodically with an increment in period of about 5 minutes under cutting condition Group 1 and 2.5 minutes under Groups 2 and 3. The tool was replaced by a fresh one at each interruption such that every tool remained in thermal continuity until it was replaced. Just before each tool replacement, a set of 524 data points was sampled for each channel and a typical record is shown is Fig.1. Therefore, the experimental results consist of 8 tools and 8 sets of data from each channel under Group 1, and 7 tools and 7 sets of data from each channel under Groups 2 and 3.

Before the dynamic cutting force in terms of its three orthogonal components were sampled into a multi-channel data acquisition system with a sample interval equal to 60 μs (about 16.7 KHz), low-pass filters with a cut-off frequency of 4 KHz were applied, considering the 4 KHz-natural frequency of the dynamometer.

3.2 Definition of Comprehensive Tool Wear Parameters and Their Measurement

Eight parameters were selected to describe the tool wear states as shown in Fig.2, primarily in accordance with CIRP tool wear terminology [13]. The eight tool wear parameters are roughly classified into three categories with respect to different tool faces, i.e., the major flank area (VB, KS & VG), crater area (KT, KB & KK) and minor flank area (VB' & N). Table 2 gives the measurement results for Group 1 by microscopy, and the tool wear developments for all three cutting conditions are plotted in Figs. 3 and 4.

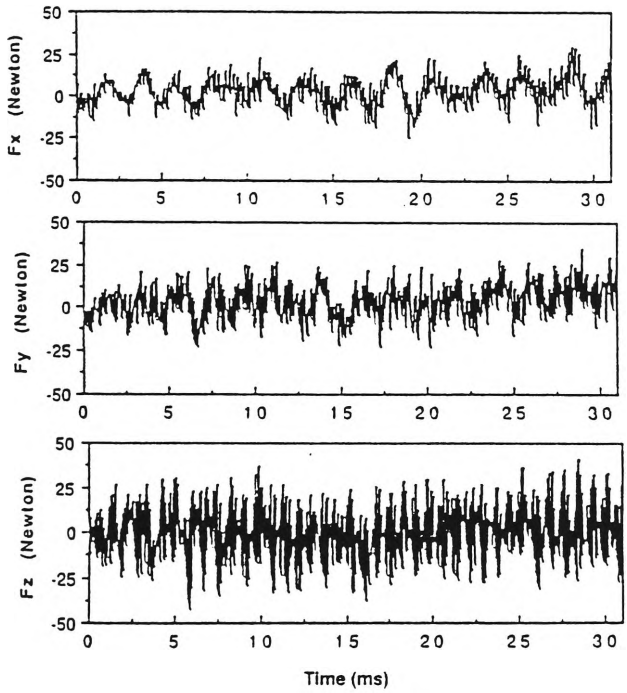
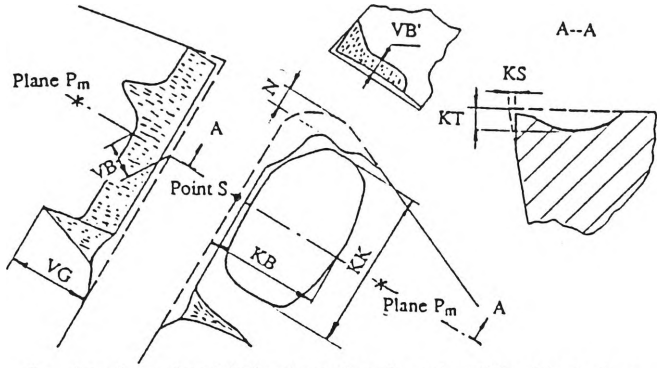


Fig. 1 Dynamic Cutting Force Measured in Terms of Its Three Orthogonal Components

Table 2 Tool Wear Measurement Results for Cutting Condition Group 1

Time (min)	VB (mm)	KS (μm)	VG (mm)	KT (μm)	KB (mm)	KK (mm)	VB' (μm)	N (μm)
0	0	0	0	0	0	0	0	0
2.67	0.12	12.8	0.09	22.2	1.1	0.4	15.3	7.1
5	0.16	25.7	0.10	33.3	1.2	0.60	28.6	21.4
10	0.26	47.1	0.40	38.8	1.2	0.63	71.4	32.8
15	0.34	80.0	0.70	66.7	1.2	0.64	185.7	54.3
20	0.58	104.3	0.75	166.7	1.4	0.66	228.6	91.4
25	0.64	127.1	0.80	205.6	1.4	0.68	235.7	112.8
34	0.73	142.8	0.84	222.2	1.5	0.70	242.8	135.7



S : the point on the original major cutting edge at the middle of depth of cut
Pm: the plane perpendicular to the major cutting edge through point S

VB:	major flank wear	VG:	length of the groove (notch)
KS :	retract of the cutting edge	KT :	crater depth on the rake face
KB:	crater width on the rake face	KK:	crater length on the rake face
VB':	minor flank wear	N :	nose wear

Fig. 2 Definition of Comprehensive Tool Wear Parameters

4. TOOL WEAR ESTIMATION BY DISPERSION ANALYSIS

4.1 ARMAV Modeling and Dispersion Analysis

Each set of data was used to develop ARMAV models first. ARMAV(9,0) models were found adequate for data collected under cutting conditions denoted as Group 1 in Table 1 and ARMAV(11,0) models for the data collected under Group 2 and 3 conditions. Given below is an example of ARMAV(9,0) model.

$$X_t = \begin{bmatrix} .448 & -.063 & -.020 \\ .140 & .808 & -.018 \\ -.034 & .128 & .333 \end{bmatrix} X_{t-1} + \begin{bmatrix} -.129 & .115 & -.108 \\ -.063 & -.349 & -.062 \\ -.043 & -.083 & .265 \end{bmatrix} X_{t-2} + \begin{bmatrix} .262 & .013 & .193 \\ -.169 & .092 & .010 \\ .164 & -.060 & .052 \end{bmatrix} X_{t-3} +$$

$$\begin{bmatrix} .342 & -.023 & -.073 \\ .103 & -.034 & -.021 \\ -.085 & .105 & .048 \end{bmatrix} X_{t-4} + \begin{bmatrix} .187 & -.001 & .005 \\ -.162 & .188 & .088 \\ -.061 & -.054 & .047 \end{bmatrix} X_{t-5} + \begin{bmatrix} .018 & .059 & .099 \\ .084 & -.058 & -.045 \\ .004 & .011 & -.105 \end{bmatrix} X_{t-6} +$$

$$\begin{bmatrix} -.200 & -.161 & .010 \\ .035 & -.021 & -.016 \\ -.108 & .054 & .179 \end{bmatrix} X_{t-7} + \begin{bmatrix} -.086 & .158 & -.028 \\ .054 & -.064 & -.035 \\ .086 & -.161 & -.131 \end{bmatrix} X_{t-8} + \begin{bmatrix} -.084 & -.057 & -.010 \\ -.003 & .012 & .105 \\ -.044 & .060 & -.003 \end{bmatrix} X_{t-9} + a_t$$

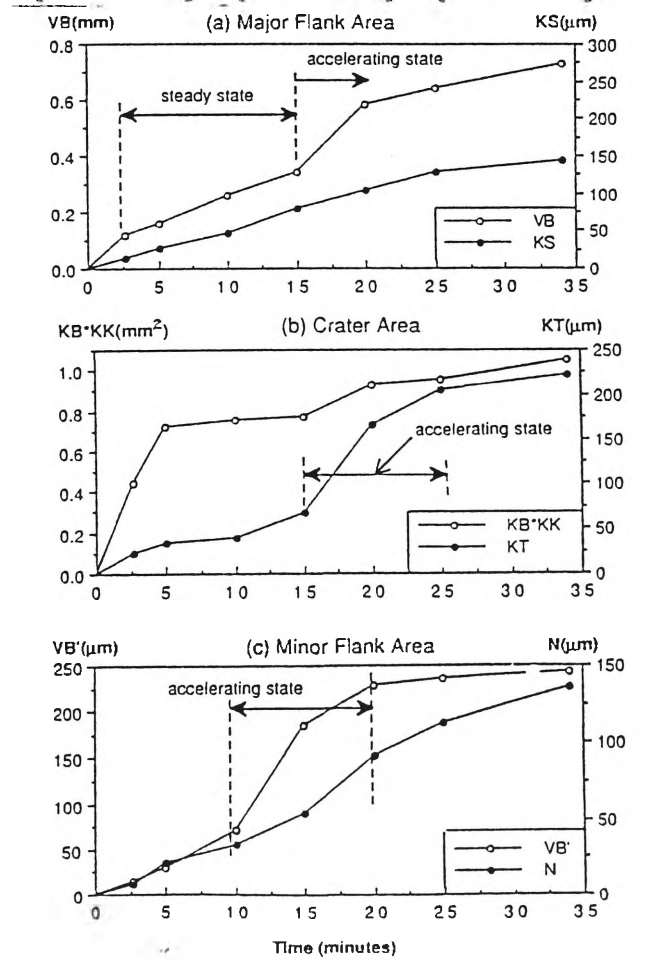


Fig. 3 Comprehensive Tool Wear Results for Cutting Condition Group 1 (V=115m/min, f=0.1mm/rev, d=0.5mm)

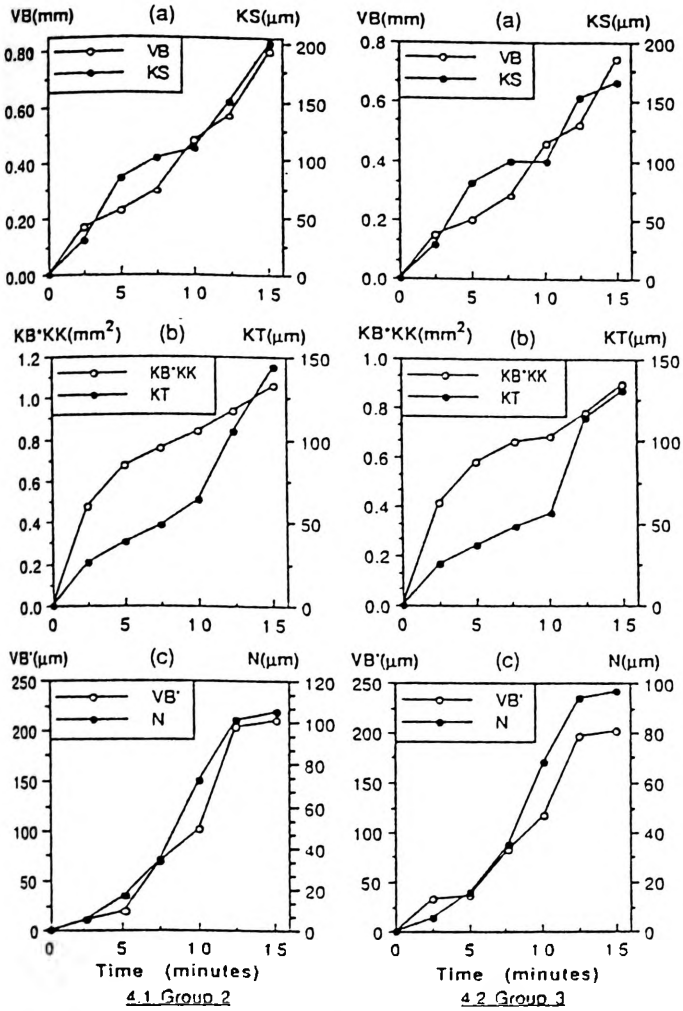


Fig.4 Comprehensive Tool Wear Results for Cutting Condition Groups 2 & 3

After an adequate model was determined, dispersion d_i's and corresponding frequencies were calculated according to Eqs. 5 and 6. The dominant d_i's (e.g. ones with larger percentage) and associated frequencies under cutting condition Group 1 are tabulated in Table 3. It is seen that the most significant dispersions are associated with a lower frequency (LF) range, and the second most significant dispersions related to a higher frequency (HF) range. The dominant dispersions for all three cutting conditions are plotted in Figs. 5 and 6, from which recognizable trends are observed which will be exploited in the following section.

Table 3 Dominant Dispersions (%) for Group 1

	Feed Force F_x		Thrust Force F_y		Main Cutting Force F_z	
Time (min)	LF (500-550 Hz)	HF (3.4-3.5 KHz)	LF (650-750 Hz)	HF (3.3-3.5 KHz)	LF (950-1050 Hz)	HF (2.6-2.8 KHz)
0	98.28	1.35	55.43	12.11	50.20	0.80
2.67	89.37	7.28	44.66	13.42	46.22	2.53
5	72.77	16.79	61.60	14.77	65.4	6.50
10	63.96	38.25	79.84	16.22	70.70	11.23
15	65.14	11.68	76.43	20.80	77.49	8.53
20	82.90	9.21	72.39	21.90	85.85	2.70
25	87.74	8.80	61.98	31.74	80.00	0.01
34	60.00	20.83	74.32	20.32	59.17	5.36

4.2 Analysis Associated with Physical Interpretation

Feed Direction: For an oblique turning operation of a bar, it is known that the feed force F_x is primarily associated with the normal force acting on the major flank $F_{\alpha n}$ and the horizontal friction force acting on the minor flank $F_{\beta h}$ (Fig.7). Therefore, the tool/workpiece interactions on both flanks should be reflected in the dynamic feed force characterisucs.

By examining the trend of LF dispersions of 500-550Hz shown in Fig.5(a), it is found that the percentage values decrease to a minimum between 10 to 15 minutes (major flank wear VB = 0.35 mm), after which they increase. It is well known from experience that cutting tools are replaced or changed when the major flank wear reaches the critical values of 0.25-0.38 mm [10]. Beyond this critical wear, the rate of wear increases very rapidly, below it the rate first decreases and then becomes constant. Thus, the behaviour of the LF dispersions isolated from the dynamic feed force is very similar to the well-known rate of major flank wear curves and could be used as a good indicator for major flank wear.

By comparing the HF dispersion curve of 3.4-3.5 KHz shown in Fig.5(a) with the minor flank wear, VB' curve shown in Fig.3(c), it is again found the former resembles the slope (rate) of the latter. The acceleration of VB' at about 10 minutes could be detected by the maximum value of the HF dispersions.

Thrust Direction: The dynamic thrust force F_y mainly reflects the tool/workpiece interactions on both the rake face and the minor flank. The small depth of cut used in finish-machining produces a large chip flow angle such that the rake face

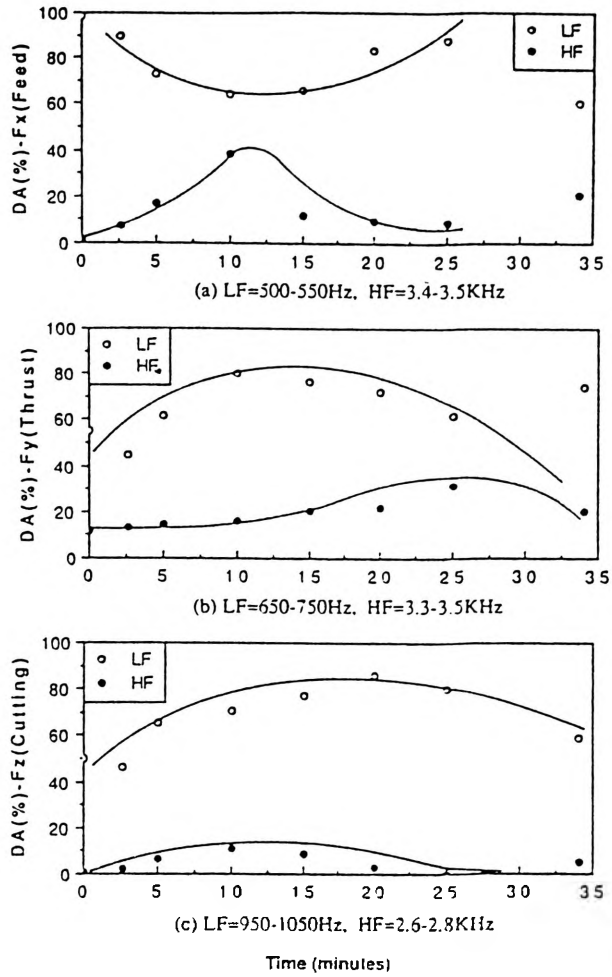


Fig. 5 Dispersion Diagram for Cutting Condition Group 1

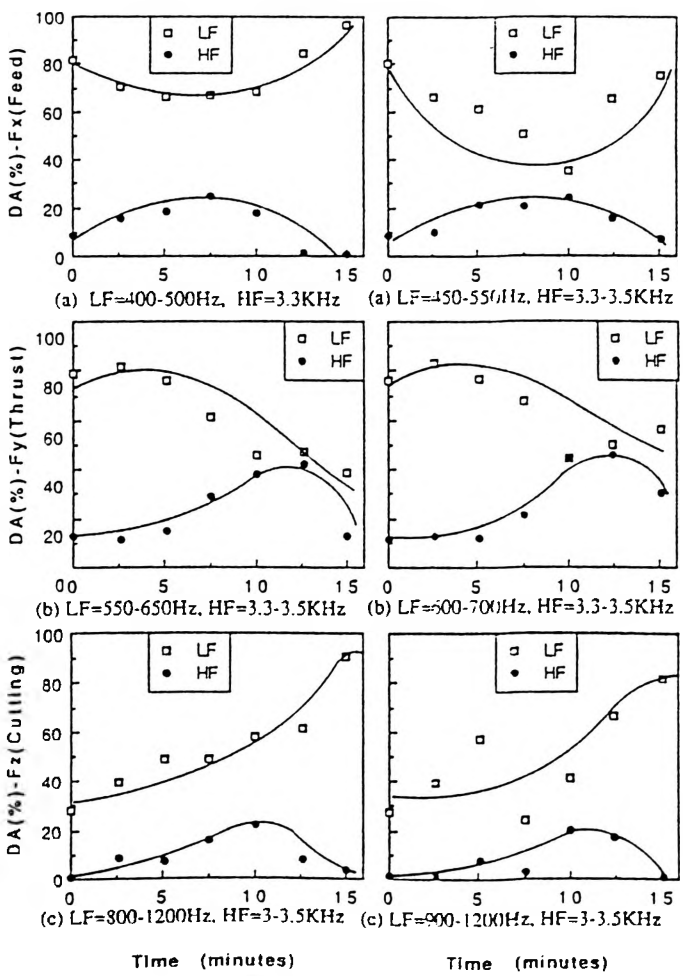


Fig. 6 Dispersion Diagrams for Cutting Condition Groups 2 & 3

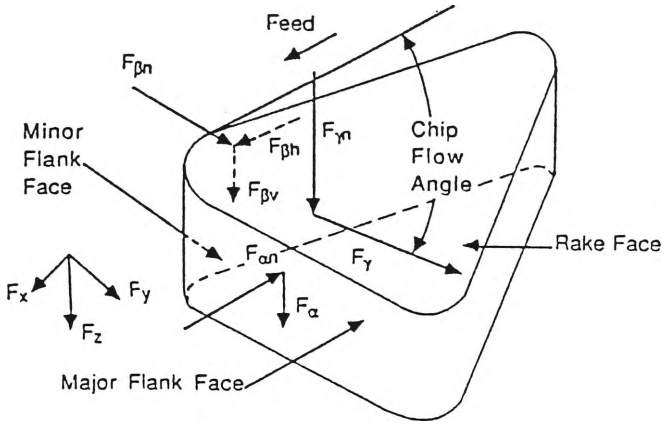


Fig. 7 Nomenclature Summary of the Forces Acting on Different Tool Faces

friction force F_γ is almost along the y direction. The normal force acting on the minor flank $F_{\beta n}$ is also associated with F_y. In a similar manner, the HF dispersions of 3.3-3.5 KHz shown in Fig.5(b) can be related to the rate of crater wear KT shown in Fig.3(b), and the LF dispersions of 650-750 Hz shown in Fig.5(b) related to the rate of the minor flank wear VB' shown in Fig.3(c). Therefore, they can be used for minor flank and crater wear monitoring purposes.

Cutting Direction: The dynamic cutting force F_z is primarily associated with the normal force acting on the rake face $F_{\gamma n}$, the friction force acting on the major flank F_α, and the vertical friction force on the minor flank $F_{\beta v}$. By examining the LF and HF dispersions of 950-1050 Hz and 2.6-2.8 KHz shown in Fig.5(c), it was found that they reflect the rate of the rake wear and the minor flank wear shown in Figs.3(b) and 3(c), respectively.

As summarized in Table 4, the trends of the LF dispersions isolated form all three components of the dynamic cutting force reflect the wear rate mechanism associated with normal forces, and the HF dispersions reflect the wear rate mechanism associated with tangential (friction) forces. Similar results were obtained for experiments under cutting condition Groups 2 and 3 as shown in Figs. 4 and 6.

Table 4 Tool Wear Analysis for Cutting Condition Group 1

F_x	$F_{\alpha n}$	(Normal to Major Flank)	↔	VB, KS	↔	LF Dispersions (500-550 Hz)
	$F_{\beta h}$	(Tangential to Minor Flank)	↔	VB', N	↔	HF Dispersions (3.4-3.5 KHz)
F_y	$F_{\beta n}$	(Normal to Minor Flank)	↔	VB', N	↔	LF Dispersions (650-750 Hz)
	F_γ	(Tangential to Crater Face)	↔	KT	↔	HF Dispersions (3.3-3.5 KHz)
F_z	$F_{\gamma n}$	(Normal to Crater Face)	↔	KT	↔	LF Dispersions (950-1050 Hz)
	$F_{\beta v}$	(Tangential to Minor Flank)	↔	VB', N	↔	HF Dispersions (2.6-2.8 KHz)
	F_α	(Tangential to Major Flank)				

5. DISCUSSION

5.1 Critical Tool Wear in Finish-Machining and Sensing Strategy

It is clear from the above results that the HF dispersion of F_x, the LF dispersion of F_y, and the HF dispersion of F_z can all be used as indicators of the rate of minor flank wear VB'. They all reached a maximum value when VB' accelerated at about 10 minutes under cutting condition Group 1. Among them the most sensitive one is the HF dispersion of F_z. The horizontal friction force on the minor flank, $F_{\beta h}$, which has been shown to be associated with the HF dispersion of F_x, is more a static than a dynamic one, because of the slow feed motion. The LF dispersion of F_y is also relatively less sensitive due to the fact that there is no feeding motion in the thrust direction. Therefore, HF dispersion of F_z can be used as the main indicator of the minor flank wear VB', and the other two as auxiliary ones. When one or more of them reaches the maximum, the accelerated minor flank wear is indicated.

In comparison to major flank and crater wear, both of which did not reach their critical points until after about 15 minutes under cutting condition Group 1, it becomes obvious that for operations such as a finish-turning of a bar, the adaptive control and effective tool change policy has to be set based on the wear states of the minor flank area, to assure geometric accuracy and surface quality of the finished workpiece.

5.2 Structural Dynamics and Idle Disturbances

Clear patterns linking the force variations in terms of dispersions and associated frequencies, isolated from dynamic cutting force, to the various wear development rates have been identified. However, the physical nature of the relationships is unclear and it is the purpose of this section to identify physical origins of these relationships and interpret accordingly.

Since almost the same HF's appear in all three groups, these frequencies are then inherent in the tool holder and hence may be conjectured to relate to its natural frequencies. Tests revealed that the natural frequencies of the tool holder/dynamometer system were 3320 Hz in the x-, 3300 Hz in the y-, and 2847 Hz in the z- directions, respectively. These values match reasonably well with the HF's isolated from the dynamic cutting force (Figs.3 and 4).

Tests on dynamometer frequency response to idle speed excitation alone revealed idle frequencies of 575 Hz for x, 715 Hz for y, and 975 Hz for z under cutting condition Group 1. These frequencies are reasonably close to the LF's listed in Table 3. From the above tests, it becomes clear that tool/workpiece interaction at the LF's are related to the idle frequencies, and the HF's are mainly associated with the natural frequencies of the tool-holder/dynamometer system.

6. CONCLUSIONS

1. Dispersion analysis based on trivariate ARMAV time series models was used to quantitatively decompose the dynamic cutting force in terms of dispersions (relative importance of modes of force variation) and associated frequencies. The merit of the method is its ability to isolate from the dynamic cutting force the ingredients, each of which is particularly sensitive to a particular wear state, thereby providing much more comprehensive yet sensitive estimates than those possible by using the force signal in a lump-sum manner.

2. The patterns of change of the dispersions resemble the rate of various wear parameters and the resemblance is physically interpreted. The rapidly increasing rate of the minor flank wear occurring before the accelerating stage of the major flank wear is due to the fact that the gradually increasing major flank wear, and retreat of the cutting edge, sharpens the nose and puts more burden on the minor flank and edge, to a point where drastic minor flank wear is inevitable. Therefore, for operations such as a finish-turning of a bar, optimum cutting conditions or effective tool change strategy have to be determined based on the minor flank wear instead of others, to assure geometric accuracy and surface quality of the finished workpiece.

3. It was the purpose of this investigation to establish relationships between the off-line measurements of wear and dispersions of dynamic force measurements, such that the latter alone will be capable of predicting wear on-line. For machining processes at normal speeds, the algorithm introduced above is sufficiently fast to determine wear states in real time. For processes with a higher speed, the algorithm could be readily reformulated into a recursive one such that faster wear developments can be traced.

ACKNOWLEDGEMENT

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Appendix III

The Research Article

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

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ABSTRACT

A flow control strategy for packet switched voice is introduced and described in this paper. It is designed in such a way as to achieve optimum network utilization and speech quality. The performance of the flow control method is evaluated by means of a simulation study.

The flow control method relies on a prediction of the current talking/silence state of all voice stations on the network. A strategy for predicting the network traffic load and two methods of calculating each station's speech rate, are simulated.

1. INTRODUCTION

In a distributed control environment such as a LAN, each station transmitting packet switched voice, must independently decide on the appropriate bit rate for the transmission of the speech signal. In this paper we consider speech as being packetised in segments of fixed duration, by means of an embedded coding system [4].

The speech from each segment is transmitted in a single packet on the network. The length of the packet is determined according to the bit rate desired for that segment of time. The bit rate must be set in such a way as to ensure that the packet loss of all stations is minimized, while at the same time maximizing the bit rate for all users. A flow control method whereby stations independently assign their bit rate, is described.

In Section 3, the performance of the flow control method is evaluated by means of an analytical and simulation study. It is shown that a system using this optimum flow control method can achieve the same speech quality as a fixed rate coding 64kbps system when the network is lightly loaded, and at the same time have the load capacity of a 16Kbps fixed coding rate system when the network load is heavy.

In Section 4, a method for predicting the network load is simulated. Two alternative methods of determining the speech bit rate for each station are assessed. The results show that the current network traffic load can be predicted reasonably accurately by using a count of the number of packets transmitted during the previous speech segment.

2. A FLOW CONTROL METHOD FOR PACKET SWITCHED VOICE

The flow control protocol varies the coding rate at each station dynamically by varying the packet length to ensure that the packet loss of all stations is minimized while at the same time

maximizing the bit rate for all users. The packet length at each station is determined from the current network load. An optimum flow control strategy will achieve the same performance as a 64Kbps fixed coding rate system when the network load is light and the same load capacity as a 16Kbps fixed coding rate system under heavy traffic load.

The communication system is assumed to be a voice only system. Each active speaker is either in talkspurt or in silence alternately. Talkspurts and silence intervals are assumed to be exponential distributed [3] with mean $1/\mu$ and $1/\lambda$ respectively, which gives an activity parameter, $p = \frac{\lambda}{\lambda+\mu}$. The probability that k speakers are in talkspurt is given by [2]:

$$\pi_k = \binom{N_v}{k} p^k (1 - p)^{N-k} \qquad (1)$$

where N_v is the number of voice stations on the network.

Each voice station generates a packet every T seconds (T is the duration of a speech segment) in talkspurt and thus if $T << 1/\mu$ and $1/\lambda$, π_k is approximately the probability that k packets are generated every T seconds.

It is also assumed that if the waiting time of any voice packet exceeds T, it is discarded automatically at the sender.

Four groups of hierarchical bits are produced by the embedded codec [4]. They are assembled into 4 mini-packets with different significance every T seconds. Between 1 and 4 mini-packets will be combined into a single packet for transmission on the network. The transmission of a packet with 4, 3, 2, or 1 mini-packets in length is equivalent to the transmission of speech with coding rate 64Kbps, 48Kbps, 32Kbps, and 16Kbps respectively.

Using the embedded coding technique (with variable coding rate r_1=16kbps, r_2=32kbps, r_3=48kbps and r_4=64kbps), the length of the packet transmitted from each active voice station every T seconds is varied according to the dynamic system load.

If k_t packets are generated in a segment , in order to avoid packet loss, the desired mean bit rate, M, for the transmission of the packets in the segment should be: $M \le \frac{C}{k_t} - \frac{h}{T}$. The channel utilization is optimum when:

$$M = \frac{C}{k_t} - \frac{h}{T} \qquad (2).$$

The system propagation delay is assumed to be negligible.

If $M \ge r_4$, the desired bit rate for all packets in the segment is 64Kbps, i.e., all packets can be transmitted with 4 mini-packets without losing packets.

If $M < r_1$, in order to minimize the packet loss, the bit rate for the transmission of any packet should be 16Kbps. i.e., the transmitted packets should be 1 mini-packet in length. The packets which do not gain access to the network at the end of the segment, are discarded. Let

p_{16}^l and $p_{discard}$ be the proportions of the transmitted packets and the discarded packets respectively. i.e.,

$$p_{16}^l = \frac{CT}{(r_1T+h)k_t} \quad (3)$$

and

$$p_{discard} = 1.0 - \frac{CT}{(r_1T+h)k_t}. \quad (4)$$

If $r_3 \le M < r_4$, in order to avoid losing packets and to maximize the bit rate for all speakers, packets should be transmitted with either 4 mini-packets (64Kbps bit rate) or 3 mini-packets (48Kbps bit rate) with proportions p_{64}^l (p_{long}) and p_{48}^s (p_{short}) respectively.

Similarly, if $r_2 \le M < r_3$, packets should be transmitted with length of 3 mini-packets or 2 mini-packets (32Kbps bit rate) with proportions p_{48}^l (p_{long}) and p_{32}^s (p_{short}) respectively.

If $r_1 \le M < r_2$, packets should be transmitted with length of 2 mini-packets or 1 mini-packet (16Kbps) with proportions p_{32}^l (p_{long}) and p_{16}^s (p_{short}).

The desired proportions can be obtained by the following equations:

$$\begin{cases} p_{64}^l + p_{48}^s = 1.0 \\ p_{64}^l k_t(r_4T+h)+p_{48}^s k_t(r_3T+h)=TC \end{cases},$$

$$\begin{cases} p_{48}^l + p_{32}^s = 1.0 \\ p_{48}^l k_t(r_3T+h)+p_{32}^s k_t(r_2T+h)=TC \end{cases},$$

and

$$\begin{cases} p_{32}^l + p_{16}^s = 1.0 \\ p_{32}^l k_t(r_2T+h)+p_{16}^s k_t(r_1T+h)=TC \end{cases}.$$

By solving the above equations, we have :

$$p_{64}^l = \frac{C}{k_t r_1} - \frac{h}{T r_1} - 3, \quad (5)$$

$$p_{48}^s = -\frac{C}{k_t r_1} + \frac{h}{T r_1} + 4, \quad (6)$$

$$p_{48}^l = \frac{C}{k_t r_1} - \frac{h}{T r_1} - 2, \quad (7)$$

$$p_{32}^s = -\frac{C}{k_t r_1} + \frac{h}{T r_1} + 3, \quad (8)$$

$$p_{32}^l = \frac{C}{k_t r_1} - \frac{h}{T r_1} - 1, \quad (9)$$

and

$$P_{16}{}^{s} = -\frac{C}{k_t r_1} + \frac{h}{T r_1} + 2. \qquad (10)$$

3. OPTIMUM FLOW CONTROL PERFORMANCE

For a system that perfectly implements the flow control strategy of Section 2, we can predict the optimal performance of the network, in terms of overall mean bit rate, and packet loss.

If we assume the number of speakers in talkspurt are distributed according to Equation (1), then we can work out the average number of packets that are transmitted with lengths of 4, 3, 2, and 1 mini-packets for a given network configuration. The fractions of packets with length of 4, 3, 2, and 1 mini-packets are given by f_4, f_3, f_2, and f_1 respectively:

$$f_4 = \frac{\sum_{i=0}^{N_{64}} i\,\pi_i + \sum_{i=N_{64}+1}^{N_{48}} i\,p_{64}{}^{l}\,\pi_i}{N_v\,p}, \qquad (11)$$

$$f_3 = \frac{\sum_{i=N_{64}+1}^{N_{48}} i\,p_{48}{}^{s}\,\pi_i + \sum_{i=N_{48}+1}^{N_{32}} i\,p_{48}{}^{l}\,\pi_i}{N_v\,p}, \qquad (12)$$

$$f_2 = \frac{\sum_{i=N_{48}+1}^{N_{32}} i\,p_{32}{}^{s}\,\pi_i + \sum_{i=N_{32}+1}^{N_{16}} i\,p_{32}{}^{l}\,\pi_i}{N_v\,p}, \qquad (13)$$

and

$$f_1 = \frac{\sum_{i=N_{32}+1}^{N_{16}} i\,p_{16}{}^{s}\,\pi_i + \sum_{i=N_{16}+1}^{N_v} i\,p_{16}{}^{l}\,\pi_i}{N_v\,p}, \qquad (14)$$

The mean coding rate can be obtained by:

$$r_{mean} = f_4\,r_4 + f_3\,r_3 + f_2\,r_2 + f_1\,r_1. \qquad (15)$$

The fraction of packet loss is given by p_{loss}, i.e.,

$$p_{loss} = \frac{\sum_{i=N_{16}+1}^{N_v} i\,p_{discard}\,\pi_i}{N_v\,p}, \qquad (16)$$

Where π_i is as defined previously in Equation (1); N_v is the number of voice stations connected to the network; p is the speech activity factor; and N_{64}, N_{48}, N_{32}, and N_{16} are the maximum numbers of packets that a fixed rate coding system with coding rate 64Kbps, 48Kbps, 32Kbps, and 16Kbps respectively, can transmit in T seconds, i.e.,

$$N_{64} = \frac{T\,C}{r_4\,T + h}, \quad N_{48} = \frac{T\,C}{r_3\,T + h}, \quad N_{32} = \frac{T\,C}{r_2\,T + h}, \text{ and } N_{16} = \frac{T\,C}{r_1.T + h}.$$

4. TRAFFIC LOAD PREDICTION METHOD AND STATION TRANSMISSION CAPACITY DETERMINATION METHODS

4.1 Prediction of Number of Active Speakers

Since in a practical system, it is impossible to know the exact number of active speakers in a segment at the beginning of that segment, a method of predicting the number of active speakers is required. Since the number of active speakers in the segment that has just passed, given by k_{t-1}, can be determined by counting the number of transmitted voice packets, we can use this information to predict the number of speakers that are active in the current segment (given by k_t).

The state-space of k_t is $\{0, 1, 2, ..., N_v\}$. The state transition probabilities Φ_{mn} for k_{t-1} can be computed by the following exact formula [2]:

$$\Phi_{mn} = p\{k_t=n \mid k_{t-1}=m\}$$
$$= \sum_{k=0}^{N_v-m} \sum_{l=0}^{m} \binom{N_v - m}{k} (1 - e^{-\lambda T})^k e^{-\lambda T (N_v - m - k)} \binom{m}{l} e^{-\mu T l} (1 - e^{-\mu T})^{m-l} \qquad (17)$$

where $k+l = n$.

If k_t is estimated accurately, the optimum system performance could be obtained by using the flow control method described in Section 1.

If k_t is over-estimated, while the mean bit rate of the received speech would be lower than that of an optimum flow control system, the load capacity would remain the same. In either of the above cases, the number of packets transmitted during a segment equals the number of packets generated in that segment.

If k_t is under-estimated loss of packets would occur during the next segment which would possibly lead to further under-estimation of k_t. The system would lose more than 1% of packets even though the number of stations has not reached the load capacity of an optimum flow control system.

If m packets are generated during segment t-1, the estimated number of packets, k_t, for segment t should be set such that $\sum_{i=0}^{k_t} \Phi_{mi} \geq 0.99$, in order to avoid more than 1% of packet loss caused by under estimating the number of speakers in talkspurt. If this rule is observed, the probability that k_t could be under estimated is less than 1%, and thus the number of packets transmitted during a segment is approximately the number of packets generated during the segment.

The number of packets, k_t, to be generated during the current segment is predicted by:

$$\sum_{i=0}^{k_t} \Phi_{mi} \geq 0.99 \qquad (18)$$

where m is the number of packets transmitted during the previous segment.

4.2 Determination of Individual Station Transmission Rate

Each station must make an individual decision on the length of the packet it transmits. This decision is based on the current estimate of the number of speakers in talkspurt for that segment, and the probabilities derived in Equations (3) to (10).

There are two alternative ways for an individual station to determine the length of each packet it transmits.

Length Determination Method-1: Stations transmit long packets until the total number of packets transmitted in the segment equals N_{long} which is the desired number of long packets calculated at the beginning of the segment. The rest of the stations will send short packets until the end of the segment.

The stations need to count the number of long and short packets that have been sent out already in that segment. This at first sight, appears unfair, as the stations at the beginning of the segment get preference. However the beginning of the segment is randomly located on the ring, as each station independently times its segment duration.

Length Determination Method-2: An individual station determines its capacity to send its current packet by comparing a uniformly distributed random number with the calculated value of p_{long}. If the random number is smaller than p_{long}, the packet will be sent as a long packet. Otherwise it is sent as a short packet. If all stations follow the same rule, the total number of long packets transmitted during a segment should be statistically the same as, or close to, the desired number, N_{long}.

5. RESULTS

The system performance was investigated by computer simulation. Each station was assumed to be generating talkspurts and silence intervals independently according to exponential distributions [3] with means $1/\mu$ = 1.2s and $1/\lambda$ = 1.8s.

It was assumed that the channel capacity was C = 1Mbps, the speech segment length was T = 16ms, the packet header length was h = 80 bits, and the coding rates were r_1 = 16kbps, r_2 = 32kbps, r_3 = 48kbps and r_4 = 64kbps. The network simulated was a token ring with negligible propagation delay.

The effectiveness of the flow control technique was evaluated by comparing the packet loss rate and the mean bit rate versus the number of voice stations as shown in Figures 1 and 2 respectively.

The 'simulated' results in Figures 1 and 2 refer to the results obtained from computer simulation, assuming exact knowledge of the number of speakers in talkspurt for each segment. (Length Determination Method-1 was used in this simulation). The 'calculated' results refer to the optimal results obtained using Equations (11) to (16) as described in Section 3.

From Figures 1 and 2, it can be seen that a mean bit rate, as high as 64Kbps, can be obtained when the network is lightly loaded. In addition, 107 stations can be accommodated by a 1Mbps system with less than 1% packet loss when the network load is heavy, which is the same as the

load capacity of a 16Kbps fixed coding rate system [1]. The results of Figures 1 and 2 show that the results obtained from the simulated flow control technique agree well with the theoretically predicted results.

Figure 3 shows the fraction of packets that are transmitted which have lengths of 4, 3, 2, and 1 mini-packets respectively.

The effectiveness of the state prediction technique for the number of speakers in talkspurt was also investigated. In the simulated results of Figures 4 and 5, expression 18 was used to predict the traffic load in each speech segment. The system performance achieved using Length Determination Methods 1 and 2 was also compared.

As can be seen from Figure 4, the packet loss rate for the system using the predicted state of the speakers, is almost identical to the case when the number of speakers is known exactly (this is referred to as "Optimum control system (simulation)" in Figures 4 and 5). This is independent of the Length Determination Method used. The method of predicting the number of speakers in talkspurt for any segment, as proposed in Section 4.1, is thus extremely effective.

The mean coding rate versus the number of stations is illustrated in Figure 5. The mean bit rates are again independent of the Length Determination Method. They are however lower than that of an optimum flow control system by about 9% . This is caused by over-estimating the number of active stations in Expression 18, which is done in order to minimize the packet loss rate.

The system performance is identical for both Length Determination Method-1 and Length Determination Method-2. Method-1 is more complicated to implement due to the necessity to count packets of different length. Method-2 only requires the total number of packets transmitted in the previous segment to be counted and thus is preferred.

6. CONCLUSION

A flow control method for variable bit rate voice traffic in packet switched networks has been proposed and described. We have shown by simulation that :

(1) the number of packets to be generated during a speech segment can be reasonably accurately predicted by using the number of packets transmitted during the previous segment;

(2) the length of the current packet to be transmitted by an individual station can be easily determined by means of a uniformly distributed random number generator;

(3) the traffic carrying capacity of an optimum flow control system can be achieved, at a cost of less than 9% of the mean bit rate.

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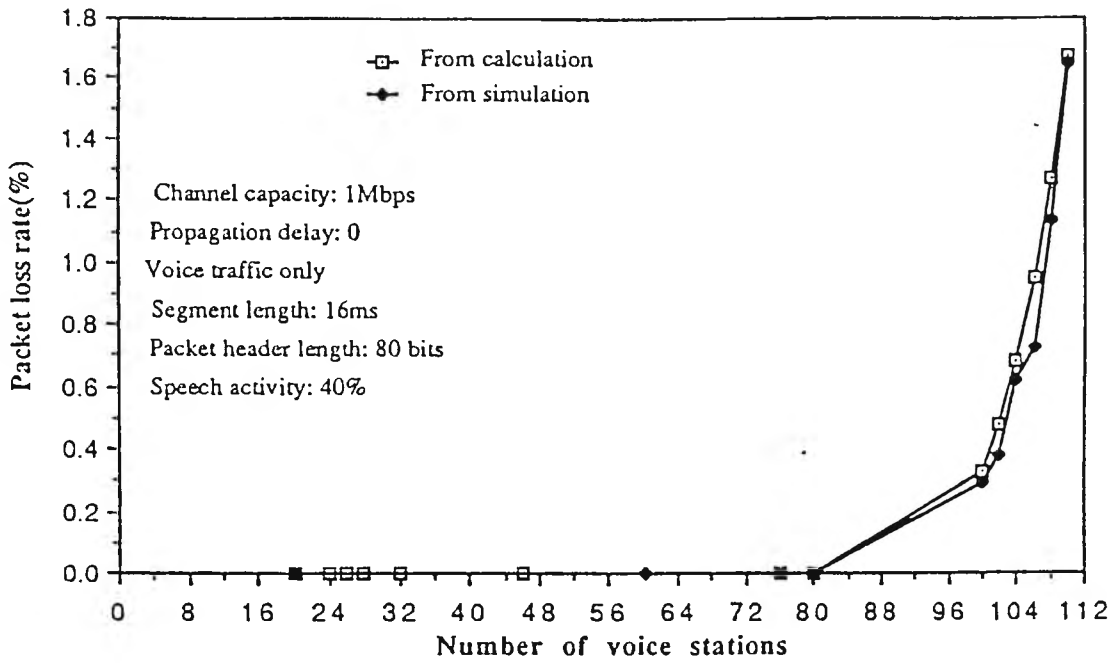

Figure - 1: Percentage of packet loss as a function of load

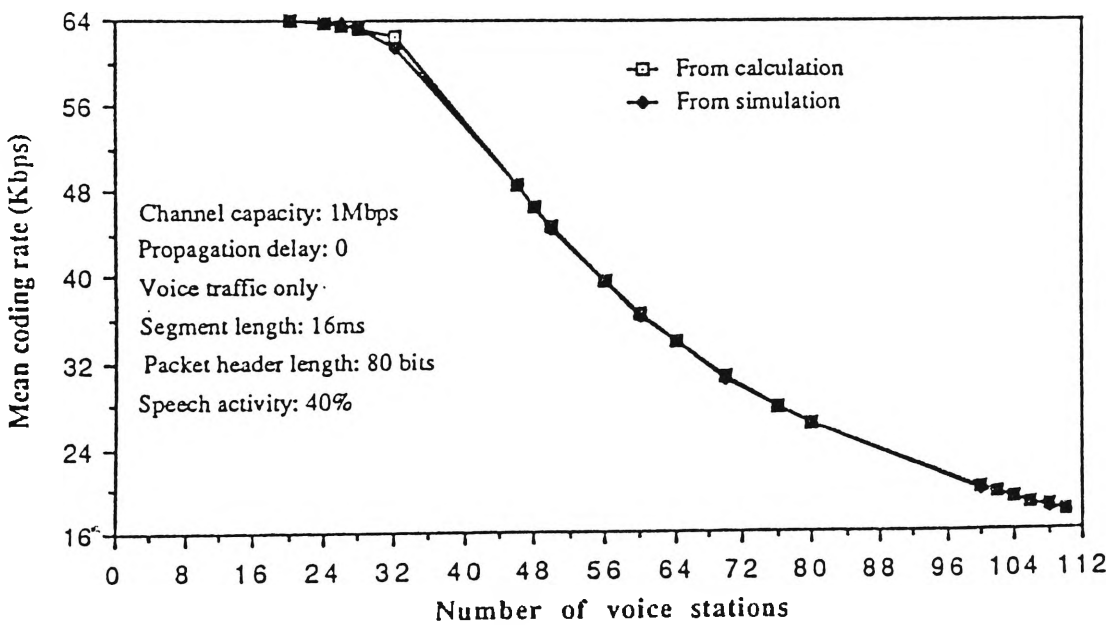

Figure - 2: Mean bit rate as a function of load

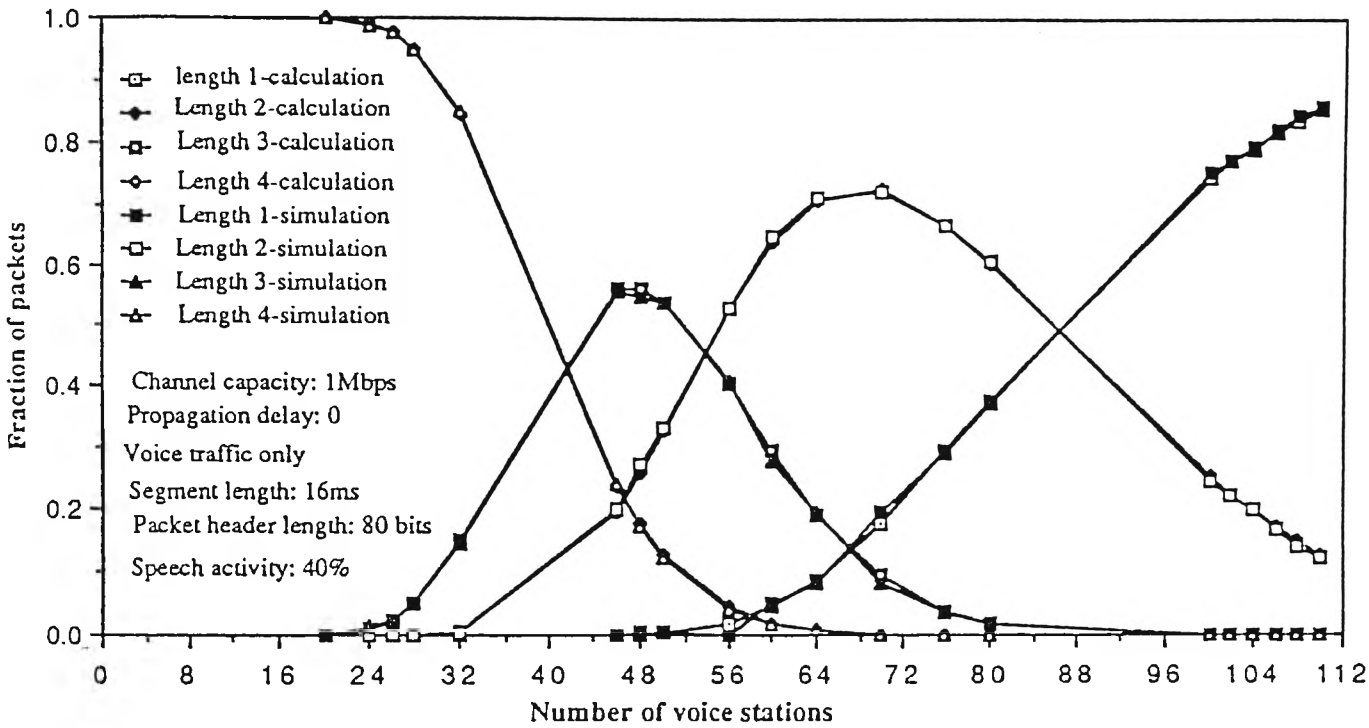

Figure - 3: Fraction of packets with length 4, 3, 2, and 1 mini-packets

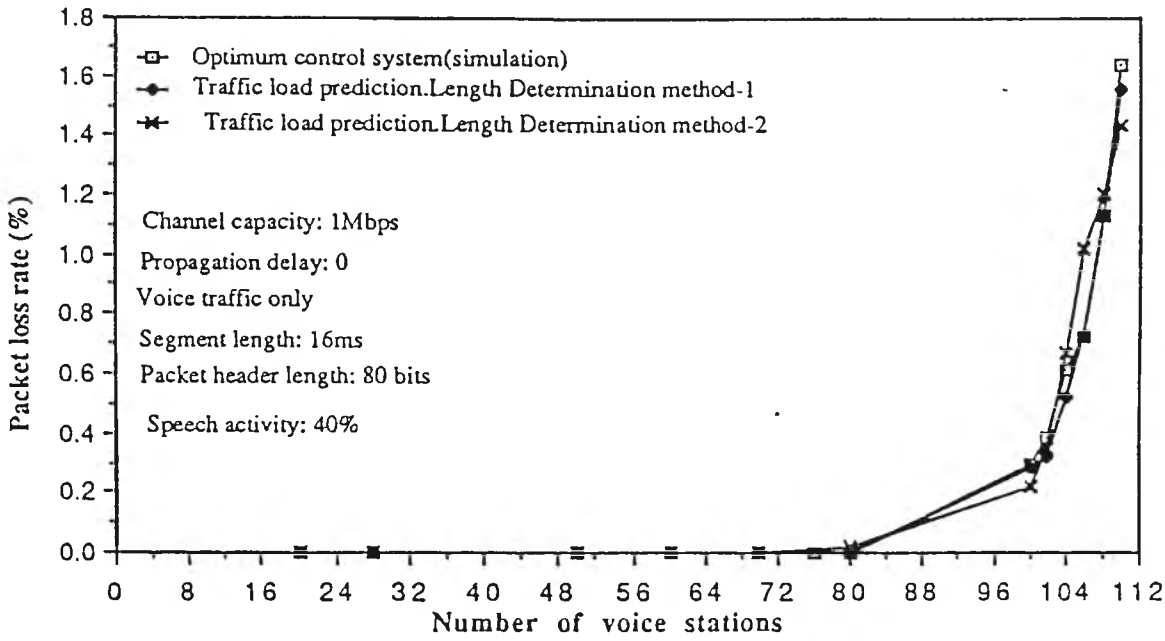

Figure - 4: Percentage of packet loss as a function of load

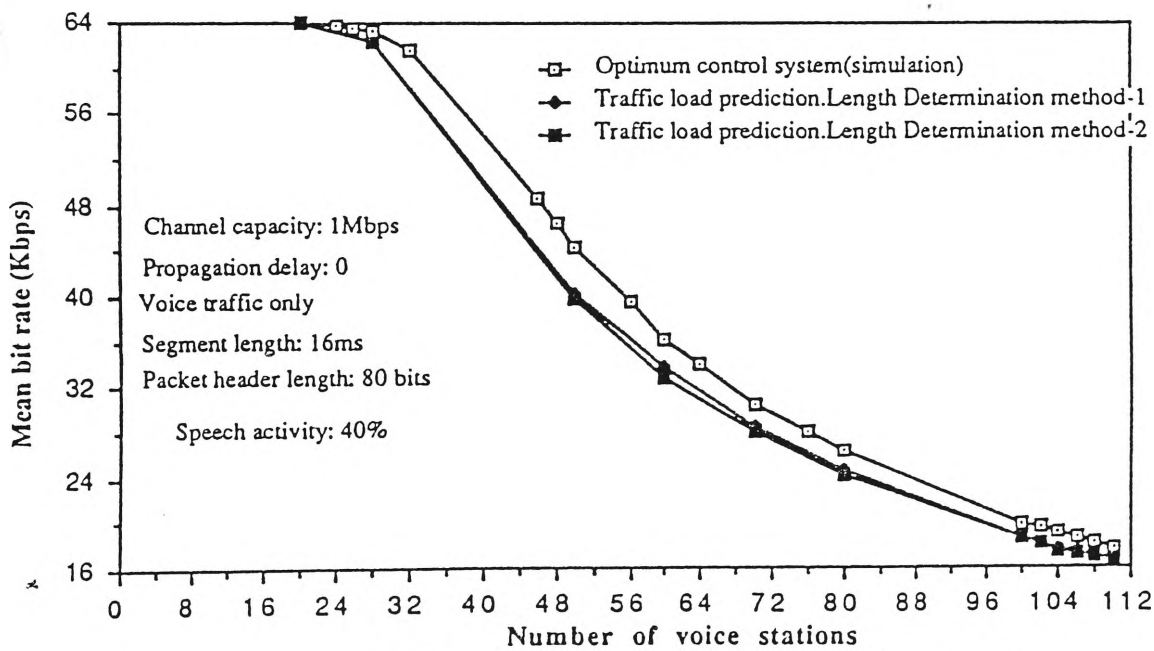

Figure - 5: Mean bit rate as a function of load

Appendix III

The Research Article

Text III

INSTANT-CHILLED STEEL DLAG AGGRAGATE IN CONCRETE-STRENGTH RELATED PROPERTIES

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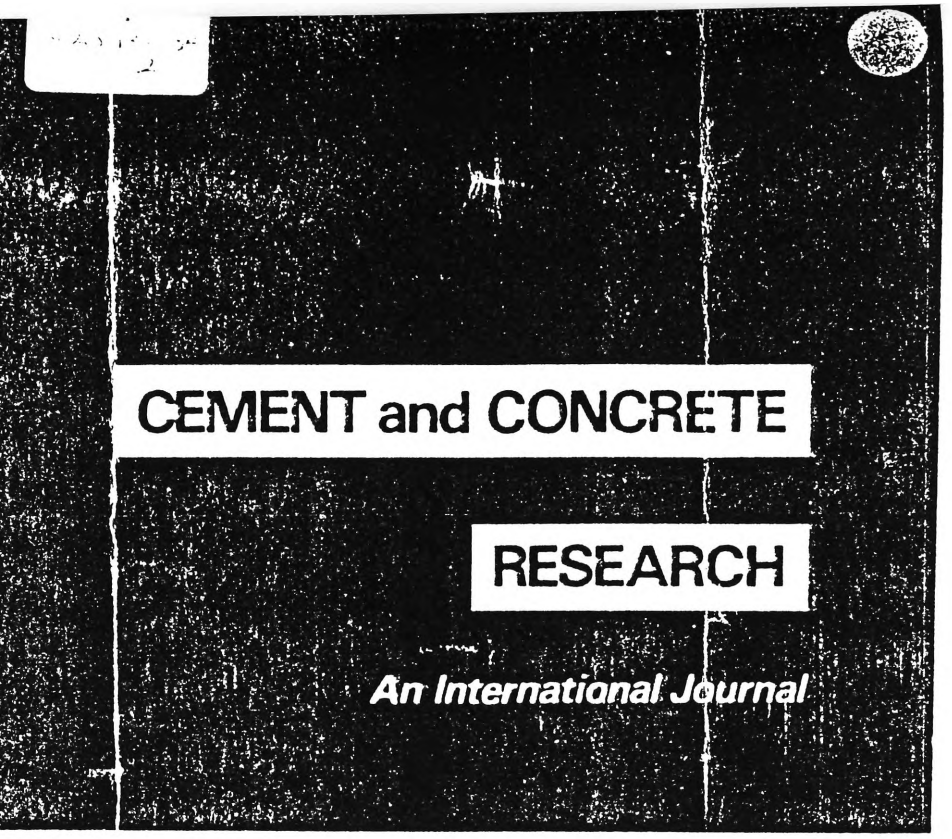

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INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

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ABSTRACT

The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented. The I.C.S. slag possesses good physical and mechanical properties and has sufficient stability for use as a coarse aggregate in concrete. Bond tests have shown that I.C.S. slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate. The tensile splitting strength of the slag aggregate itself is higher than that of limestone. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate.

Introduction

The use of supplementary materials is becoming of increasing importance in concreting practice (1,2). These materials can be incorporated in concrete to facilitate several benefits including the modification and improvement of certain material properties, the conservation of non-renewable natural resources and the utilisation of industrial by-products.

Blast furnace slag has been widely used in concretes for many years, both as a cementing medium and aggregate (3,4,5). In more recent years the potential use of steel slag has been investigated (6,7,8). This material can be potentially hazardous, the major concerns over its use in concrete being associated with volume stability arising from the effects of M_gO and F-CaO (9).

Several processes have been developed for slag treatment (7,10,11). Generally these processes are utilised to provide cooling and limited crushing of the molten slag. They range in technique from the extensive use of high pressure water, steam or air to provide cracking and, in some cases granulation, to the dry process which utilises natural cracking on solidification of thin layers of the hot slag by water sprinkling.

This paper describes some mechanical properties of steel slag concrete in which the steel slag has been processed in a particular manner to produce instant-chilled steel slag (I.C.S.). This process is

also known as shallow box chilling (11). The slag was produced at the Baoshan Iron-Steel Works, Shanghai, China.

Instant Chilling Process

The instant chilling process utilised consists essentially of four stages. The first stage is air cooling where the molten slag is located on shallow plates to give a bed thickness of approximately 100mm and air cooled for four minutes. This is followed by an initial water cooling cycle during which the slag bed is continuously water sprayed for approximately twenty minutes to produce an end temperature of 500°C. After initial water cooling the slag is loaded into slag carts and transported to a spraying station for further water spraying for four minutes and an end temperature of 200°C. Finally the slag is placed in a water pool and cooled to around 60°C to complete the process ready for magnetic screening. The slag is treated in a batch-process with total treatment time of 1.5 to 2.5 hours. This treatment process generally produces low pollution and particle size 30-50mm with low F-CaO content (2-4%). Because relatively thin slag layers are water sprayed in the shallow box the risk of explosion due to steam generation and entrapment is avoided.

Experimental Program

Materials

The cement used in the present study was No. 525 Portland Cement. This corresponds to Type A - ordinary Portland cement.

The coarse aggregates used in the concrete mixes were crushed limestone and I.C.S. slag. The properties of the I.C.S. slag are presented in Table 1. F-CaO content of the I.C.S. slag was less than 4%. MgO existed as mixed crystals in RO phase, these being not deleterious to volume stability. No periclase existed in the slag.

The fine aggregate was a medium sand.

Common tap water was used in all mixes.

TABLE I
Properties of I.C.S. Slag

Aggregate crushing value	4.8%	8.7% (limestone)
Water absorption	2.5%	2.3% (limestone)
Free water content	1.4%	1.1% (limestone)
Specific gravity	3.61	2.54 (limestone)
Unit mass (uncompacted)	1680 kg/m^3	1350 kg/m^3 (limestone)

Grading

Sieve size (mm)	20	15	10	5	2.5
% Passing (by wt.)	100	90.5	38.7	1.6	1.6

Chemical composition

SiO_2	Al_2O_3	T Fe	CaO	MgO	P_2O_5	f-CaO	Alkalinity *(B)
18.9	1.7	22.4	43.3	8.4	1.0	3.8	2.17

* $B = \frac{CaO\%}{SiO_2\% + P_2O_5\%}$

Hydrothermal test

After 8 hours at 100°C, powdering ratio S was 0.46%

Autoclave test

After 8 hours at 175°C (8 atm), powdering ratio S was 1.47%

Bond

Series of tests were performed to determine the degree of bond achieved between the aggregate and matrix. Tests were carried out for three different water/cement ratios (0.3, 0.35, 0.4).

Tensile splitting strength on 30mm cubes was taken as an indication of bond strength.

The experimental programme is represented in Table 2. Individual tests were carried out to determine tensile splitting strengths of the mortar (matrix), aggregate particle (dispersed phase), aggregate/mortar interface (interface) and concrete.

TABLE 2
Experimental Programme
Bond Tests - Aggregate/Matrix Interface

Mix Type	Phase	Materials	Specimen Size (mm)	Mix Proportion 1 W/C = 0.30	2 W/C = 0.35	3 W/C = 0.40
1	MATRIX	MORTAR	30 x 30 x 30	CEMENT:SAND = 1:2		
2	DISPERSED PHASE	LIMESTONE L.C.S. SLAG	30 x 30 x 30 30 x 30 x 30	SAWN, NOT POLISHED		
3	INTERFACE	L'STONE & MORTAR SLAG & MORTAR	30 x 30 x 30 COMBINED	CEMENT:SAND = 1:2		
4	CONCRETE	LIMESTONE AGG. L.C.S. SLAG AGG.	30 x 30 x 30 30 x 30 x 30	CEMENT:SAND:COARSE AGG 1 : 2 : 3.5		

Microhardness

Microhardness measurements were made on the sawn surfaces of specimens to determine variation in hardness throughout the interfacial region between I.C.S. slag (fine particle size material ≈ 3mm diameter) and cement paste and sand grains and cement paste.

Strength and Elastic Modulus

The use of I.C.S. slag and crushed limestone aggregates in concrete mixes was investigated. Concrete mixes of constant W/C ratio (0.5) were made in which the slag contents as a percentage of total coarse aggregate were varied from 0 to 100%. Mix proportions are shown in Table 3.

TABLE 3
Mix Proportions for Concrete Tests
I.C.S. Slag and Limestone Coarse Aggregates

		MATERIALS USED BY WEIGHT (kg/m^3)				MIX RATIO	SLAG (SLAG+STONE)	
MIX NO	W/C	CEMENT	SAND	CRUSHED LIMESTONE	I.C.S. SLAG	C:S:CL:ICS SLAG	BY VOL	BY WT
1 - 0	0.5	420	620	1150	0	1:1.48:2.74:0.00	0%	0%
1 - 2	0.5	420	620	920	286	1:1.48:2.19:0.68	20%	24%
1 - 4	0.5	420	620	690	572	1:1.48:1.64:1.36	40%	45%
1 - 6	0.5	420	620	460	859	1:1.48:1.10:2.04	60%	65%
1 - 8	0.5	420	620	230	1145	1:1.48:0.55:2.73	80%	83%
1 - 10	0.5	420	620	0	1431	1:1.48:0.00:3.40	100%	100%

Note: 1. Coarse aggregates are crushed limestone and I.C.S. slag
2. Fine aggregate is medium sand
3. Cement corresponds to type A O.P.C.

Results and Discussion

Bond

Experimental results of the bond tests are shown in Table 4.

From examination of the results it can be seen that the tensile splitting strength of I.C.S. slag is approximately 17% higher than that of crushed limestone. This is partly the result of the higher specific gravity of the slag (3.61) compared with that of the crushed limestone (2.54). However the slag particles are more porous than limestone resulting in higher water absorption (2.5% cf. 2.3%) and free water content (1.4% cf. 1.05%). Aggregate crushing value of slag is lower than that of limestone (4.8% cf. 8.7%).

The bond strengths between I.C.S. slag and mortar are higher than those between crushed limestone and mortar. The relative increase in bond strength is dependent on water/cement ratio

used for the mortar with the greatest increase in strength being obtained for higher water/cement ratio. Relative increases in bond strength for the three water/cement ratios are 13% (0.3); 27% (0.35); 50% (0.40).

Tensile splitting strengths of concretes containing L.C.S. slag as coarse aggregate are higher than those of concretes containing crushed limestone. The relative increases are similar to those for bond strengths, being 15% (0.30); 30% (0.35); 42% (0.40).

The ratios of $\frac{\sigma \text{ INTER}}{\sigma \text{ MATRIX}}$ and $\frac{\sigma \text{ INTER}}{\sigma \text{ DISP}}$ are generally higher for L.C.S. slag than for limestone aggregate. The improvement in interface strength results in a stronger composite material.

TABLE 4
Experimental Results for Bond Tests

MIX TYPE	TENSILE SPLITTING STRENGTH (MPa)			STRENGTH RATIO OF PHASES					
	1	2	3		1	2	3	MEAN	
1	3.8	3.1	2.6	σ_{INTER}	0.39	0.35	0.31	0.35	CRUSHED LIMESTONE
2	4.6 (LIMESTONE) 5.4 (L.C.S. SLAG)			σ_{MATRIX}	0.45	0.45	0.46	0.45	L.C.S. SLAG
3	1.5 1.7	1.1 1.4	0.8 1.2	σ_{INTER}	0.33	0.24	0.17	0.25	CRUSHED LIMESTONE
4	2.6 3.0	2.0 2.6	1.2 1.7	σ_{DISP}	0.31	0.26	0.22	0.26	L.C.S. SLAG

Microhardness

Distributions of microhardness in the transition zone of interface between the aggregate particles and the hardened cement paste are shown in Fig. 1.

Maximum values of microhardness occur in the cement paste in close vicinity to the aggregate, at distances up to 25μm from the interface, for both sand and slag particles. In the region 25-100 μm from the interface the microhardness values, at 28 days, for slag/paste composite are considerably higher than those for the sand/paste composite. At distances greater than 100 μm from the interface hardness values are comparable for both composites.

For both composites, at both ages, hardness decreases with increasing distance from the interface in the region to 100 μm. At further distances from the interface the hardness gradually increases, thus exhibiting a pessimum value range for all composites. In general the pessimum values for slag/paste composites are slightly further from the interface than those for the sand/paste composites.

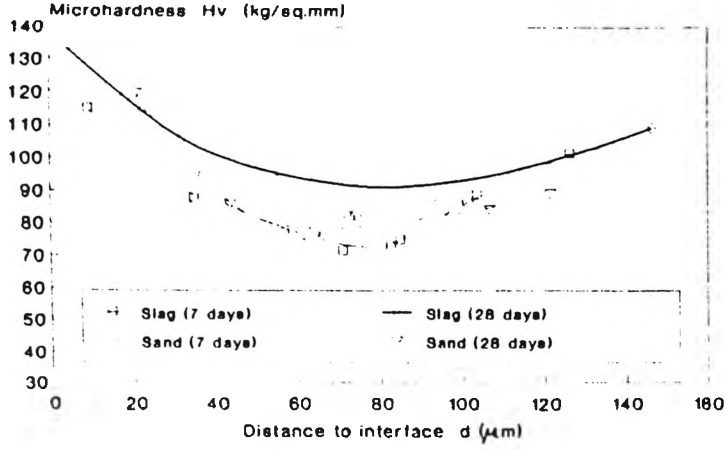

FIG. 1
Microhardness in Transition Zone
of Interface between Aggregate and hcp

Strength and Elastic Modulus

The experimental results of strength and elastic modulus related tests on various specimen geometries are shown in Figs. 2, 3, 4, 5.

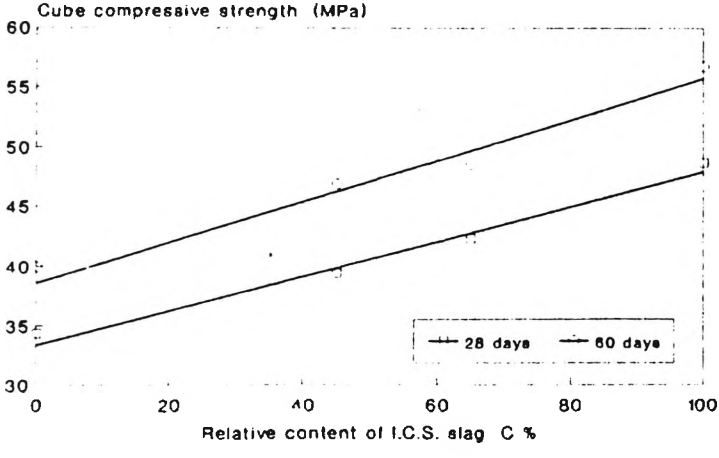

FIG. 2
Cube Compressive Strength v. I.C.S.
Slag coarse Aggregate Content

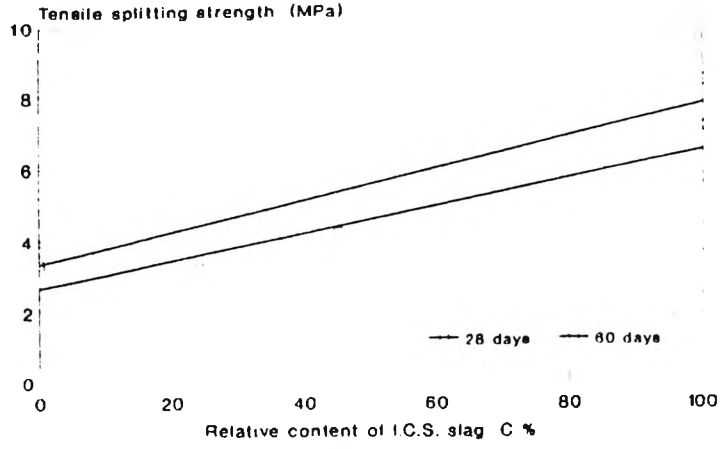

FIG. 3
Tensile Splitting Strength v. I.C.S. Slag Coarse Aggregate Content

From Fig. 2 it can be seen that compressive strength of the concrete cubes increases linearly with increase in slag content for specimens tested at 28 days and 60 days.

Tensile splitting strength, Fig. 3 increases with increase in slag content with the most significant improvement occurring at high slag replacement levels. Flexural strength, Fig. 4 remains

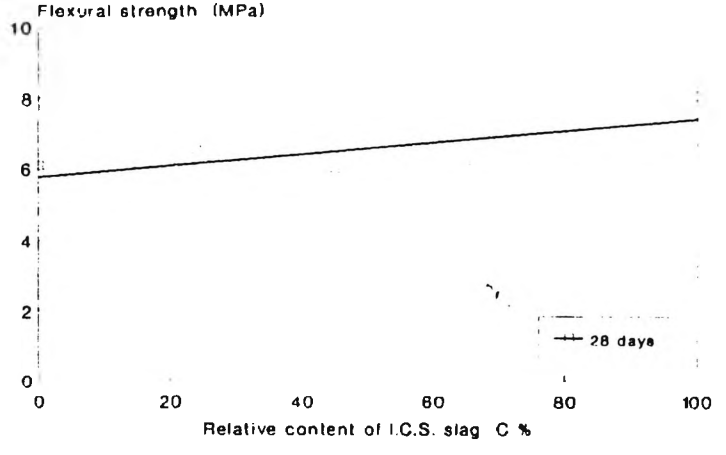

FIG. 4
Flexural Strength v. I.C.S. Slag Coarse Aggregate Content

essentially constant at slag replacement levels up to 65% with considerable increase occurring at higher values of slag content. As shown in Fig. 5 modulus of elasticity exhibits similar trends to those of compressive strength.

Examination of the fracture surfaces of the concrete cubes after tensile splitting indicated that, as the I.C.S. slag content is increased, there is a significant decrease in interfacial fracture between the aggregate particles and the mortar, with the I.C.S. slag showing no tendency to debond from the matrix. This indicated that the interfacial bond is improved, resulting in a general increase in strength of the concrete with high slag content.

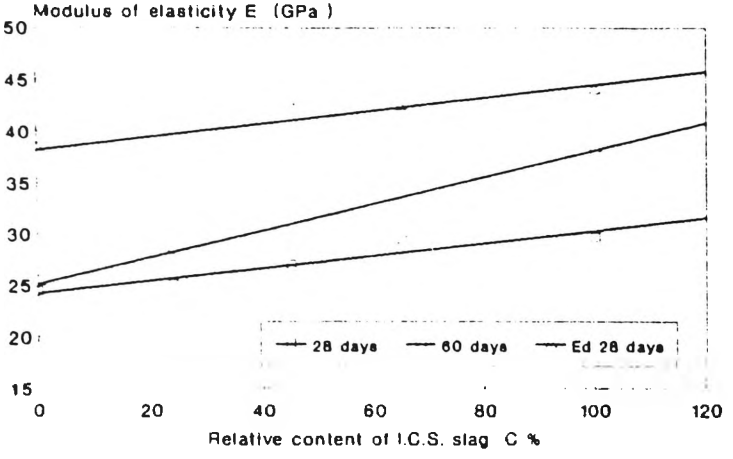

FIG. 5
Modulus of Elasticity v. I.C.S.
Slag Coarse Aggregate Content

Conclusions

Instant chilled steel slag, as produced by Baoshan Iron-Steel works, Shanghai has sufficient stability to be used as aggregate in concrete. F-CaO content is less than 4%. MgO exists as mixed crystals in RO phase and no periclase exists in the slag. Hydrothermal breakdown (powdering ratio) of I.C.S. slag is very low (<0.5%). Even under severe conditions of autoclaving (175°C), powdering ratio is less than 1.5%.

Tensile splitting strength of I.C.S. slag is greater than that of limestone aggregate.

Bond strengths of I.C.S. slag/mortar interface are higher than those of limestone aggregate/mortar interface.

Compressive strength, tensile splitting strength, flexure strength and modulus of elasticity all increase in value with increase in relative content of I.C.S. slag coarse aggregate. Concrete mixes containing I.C.S. slag as total coarse aggregate content exhibit increases of 45% and 120%, for compressive and tensile splitting strengths respectively, over those containing limestone as total aggregate content.

The interfacial region between I.C.S. slag and mortar or hardened cement paste appears to be enhanced. It is considered that this is a result of chemical reaction and mechanical interlock due to the angular shape and texture of the I.C.S. slag.

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Appendix IV

Genre and the Schematic Structure

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area. This paper describes an investigation into "comprehesive"tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.

(Problem)
(Area of study)

The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on these, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear.

Description or Recount of study

The results show that minor flank wear reaches a critical value first in finish-machining, so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear. The result also show that the method is a feasible means for on-line tool wear monitoring in finish-machining.

Results
(Implications / Recommendations)

Appendix IV

Genre and the Schematic Structure

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

A flow control strategy for packet switched voice is introduced and described in this paper. It is designed in such a way as to achieve an optimum network utilisation and speech quality. — Area of study

The performance of the flow control method is evaluated by means of a simulation study. The flow control method relies on a prediction of the current talking/silence state of all voice stations on the network. A strategy for predicting the network traffic load and two methods of calculating each station' s speech rate, are simulated. — Description of Study

Appendix IV

Genre and the Schematic Structure

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Abstract

The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented. — Area of study

The I.C.S. slag possesses good physical and mechanical properties and has sufficient stability for use as a coarse aggregate in concrete. — Description of study

Bond tests have shown that I.C.S.slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate. The tensile splitting strength of the slag aggregate itself is higher than that of limestone. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate. — Results

Appendix V

The Analysis of Transitivity

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Serise Analysis of 3-D Cutting Forces

1. In finish-machining,	geometric accuracy and surface quality	are adversely affected by
Circumstance	Participant	Process<----->Process
Location	Goal	Material<---->Material

the tool wear	at the minor flank and nose area.
Participant	Circumstance
Actor	Location

2. This paper	describes	an investigation into "comprehensive" tool wear estimation,
Participant	Process	Participant
Actor	Material	Goal

including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic
Participant
Goal

cutting force in oblique machining.
Participant
Goal

3. The force, measured in terms of its three orthogonal components,	was used
Participant	Process
Goal	Material

4. to develop	trivariate Autoregressive Moving Average Vector (ARMAV) time series models.
Process	Participant
Material	Goal

5. Based	on these,
Process	Participant
Material	Actor

6. dispersion analysis (DA)	was used
Paricipant	Process
Goal	Material

7. to extract	features sensitive to the rate of various types of wear
Process	Participant
Material	Goal

8. The results	show
Participant	Process
Actor	Material

9. that	minor flank wear	reaches	a critical value	first	in finish-machining,
	Participant	Process	Participant	Cir.	Circumstance
	Actor	Material	Goal	Time	Location

10. so that	optimum cutting conditions or an appropriate tool change strategy
	Participant
	Goal

must be determined	on the basis of minor flank wear.
Process	Circumstance
Material	Mean

11. The results	also	show
Participant		Process
Actor		Material

12. that	the method	is	a feasible means
	Participant	Process	Participant
	Carrier	Attributive	Attribute

for on-line tool wear monitoring	in finish-machining.
Circumstance	Circumstance
Purpose	Location

Appendix V

The Analysis of Transitivity

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

1. A flow control strategy for packet switched voice	is introduced
participant	Process
Goal	Material

2. and	described	in this paper.
	Process	Circumstance
	Material	Location

3. It	is designed	in such a way as to achieve an optimum network utilisation and speech quality.
Participant	Process	Circumstance
Goal	Material	Manner

4. The performance of the flow control method	is evaluated	by means of a simulation study.
Participant	Process	Circumstance
Goal	Material	Manner

5. The flow control method	relies on	a prediction of the current talking / silence state of
Participant	Process	Participant
Actor	Material	Goal

all voice stations on the network.
Participant
Goal

6. A strategy for predicting the network traffic load and two methods of calculating each station' s speech rate,
Participant
Goal

are simulated.
Process
Material

Appendix V

The Analysis of Transitivity

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

1. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate	are presented.
Participant	Process
Goal	Material

2. The I.C.S. slag	possesses	good physical and mechanical properties
Participant	Process	Participant
Carrier: Possessor	Possession	Attribute: Possessed

3. and	has	sufficient stability	for use	as a coarse aggregate	in concrete.
	Process	Participant	Circumstance	Circumstance	Circumstance
	Possession	Attribute: Possessed	Purpose	Means	Location

4. Bond tests	have shown
Participant	Process
Actor	Material

5. that I.C.S.slag	exhibits	higher interfacial bond splitting strength
Participant	Process	Participant
Actor	Material	Goal

with cement mortar	than that of limestone aggregate.
Circumstance	Circumstance
Means	Comparison

6. The tensile splitting strength of the slag aggregate itself
Participant
Carrier

is	higher	than that of limestone.
Process	Participant	Circumstance
Attributive	Attribute	Comparison

7. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes	were
Participant	Process
Carrier	Attributive

greater	than those of corresponding control concretes containing limestone aggregate.
Participant	Circumstance
Attribute	Comparison

Appendix VI

The Analysis of Theme and Rheme

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

Theme	Rheme
1. *In finish-machining,* geometric accuracy and surface quality	are adversely affected by the tool wear at the minor flank and nose area.
2. This paper	describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.
3. The force, measured in terms of its three orthogonal components,	was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models.
4.	Based on these,
5. dispersion analysis (DA)	was used to extract features sensitive to the rate of various types of wear.
6. The results	show
7. that minor flank wear	reaches a critical value first in finish-machining,
8. so that optimum cutting conditions or an appropriate tool change strategy	must be determined on the basis of minor flank wear.
9. The results	also show
10. that the method	is a feasible means for on-line tool wear monitoring in finish-machining.

*The underlined Themes are Textual Themes, and the italicised Themes are Marked Themes.

The rest are Topical Themes.

Appendix VI

The Analysis of Theme and Rheme

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

Theme	**Rheme**
1. A flow control strategy for packet switched voice	is introduced
2. and	described in this paper.
3. It	is designed in such a way as to achieve an optimum network utilisation and speech quality.
4. The performance of the flow control method	is evaluated by means of a simulation study.
5. The flow control method	relies on a prediction of the current talking / silence state of all voice stations on the network.
6. A strategy for predicting the network traffic load and two methods of calculating each station's speech rate,	are simulated.

*The underlined Themes are Textual Themes, and the italicised Themes are Marked Themes.

The rest are Topical Themes.

Appendix VI

The Analysis of Theme and Rheme

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Theme	Rheme
1. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate	are presented.
2. The I.C.S. slag	possesses good physical and mechanical properties
3. and	has sufficient stability for use as a coarse aggregate in concrete.
4. Bond tests	have shown
5. that I.C.S.slag	exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate.
6. The tensile splitting strength of the slag aggregate itself	is higher than that of limestone.
7. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes	were greater than those of corresponding control concretes containing limestone aggregate.

*The underlined Themes are Textual Themes, and the italicised Themes are Marked Themes. The rest are Topical Themes.

Appendix VII

The Analysis of Cohesion (Reference, Substitues & Ellipsis)

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining. The(1) force, measured in terms of its(2) three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models. Based on *these*, dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear. The results show that minor flank wear reaches a critical value first in finish-machining, so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear. The results also show that the method is a feasible means for on-line tool wear monitoring in finish-machining.

*The underlined parts are References, and the italic parts are Substitutes. The parts with dots (...) are Ellipsis. There is no Ellipsis in this abstract.

Appendix VII

The Analysis of Cohesion (Reference, Substitutes & Ellipsis)

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

A flow control strategy for packet switched voice is introduced and ... described in this paper. It (1) is designed in such a way as to achieve an optimum network utilisation and speech quality. The performance of the flow control method is evaluated by means of a simulation study.

The flow control method relies on a prediction of the current talking/silence state of all voice stations on the(2) network. A strategy for predicting the network traffic load and two methods of calculating each station' s speech rate, are simulated.

*The underlined parts are References, and the italic parts are Substitutes. The parts with dots (...) are Ellipsis. There is not any Substitute in this abstract.

Appendix VII

The Analysis of Cohesion (Reference, Substitute & Ellipsis)

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

The(1) properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented. The(2) I.C.S. slag possesses good physical and mechanical properties and ...has sufficient stability for use as a coarse aggregate in concrete. Bond tests have shown that I.C.S.slag exhibits higher (3) interfacial bond splitting strength with cement mortar than *that* of limestone aggregate. The tensile splitting strength of the slag aggregate itself is higher(4) than *that* of limestone. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater(5) than *those* of corresponding control concretes containing limestone aggregate.

*The underlined parts are References, and the italic parts are Substitutes. The parts with dots (...) are Ellipsis.

Appendix VIII

The Analysis of Cohesion (Conjunctions)

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

1. In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.
2. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.
3. The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models.
4. Based on these,
5. dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear.
6. The results show
7. that minor flank wear reaches a critical value first in finish-machining,
8. so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear.
9. The results also show
10. that the method is a feasible means for on-line tool wear monitoring in finish-machining.

Appendix VIII

The Analysis of Cohesion (Conjunctions)

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

1. A flow control strategy for packet switched voice is introduced
2. and described in this paper.
3. It is designed in such a way as to achieve an optimum network utilisation and speech quality.
4. The performance of the flow control method is evaluated by means of a simulation study.
5. The flow control method relies on a prediction of the current talking/silence state of all voice stations on the network.
6. A strategy for predicting the network traffic load and two methods of calculating each station's speech rate, are simulated.

Appendix VIII

The Analysis of Cohesion (conjunctions)

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Abstract

1. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented.
2. The I.C.S. slag possesses good physical and mechanical properties
3. and has sufficient stability for use as a coarse aggregate in concrete.
4. Bond tests have shown
5. that I.C.S.slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate.
6. The tensile splitting strength of the slag aggregate itself is higher than that of limestone.
7. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate.

Appendix IX

The Analysis of Cohesion (Lexical Cohesion)

Text I:

Comprehensive Tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

Comprehensive Tool Wear Estimation	Finish-Machining	Multivariate Time-Series Analysis	3-D Cutting Forces	Points of tool Wear	Article
Meronymy				*Meronymy*	
1 Geometric accuracy	finish-machining			the tool wear	
Surface quality				*Meronymy*	
Meronymy				the minor flank	
				Meronymy	
				nose area	
2 an investigation into		*Hyponymy*	*Hyponymy*	*Mero.*	*Mero.*
"comprehensive"		an analysis	dynamic cutting	flank-, crater-	This
tool wear estimation			force	*Mero.*	paper
				minor flank-	
				Mero.	
			Hyponymy	nose area	
3			The force, measured in terms of its three orthogonal components		
		Meronymy			
4		Tricariate Autoregressive Moving Average Vector Time Series models			
		Hyponymy			
Meronymy		dispersion analysis		*Mero.*	
6 the rate				various types	
		Meronymy		of wear	
7 *Hyponymy*	*Repitition*	the results		*Mero.*	
8 a critical valu	finish-machining	*Meronymy*		minor flank	
9		optimum cutting condition		wear	
		Meronymy			
		appropriate tool change strategy			
		Meronymy			
10 *Hyponymy*	*Repitition*	the results			
11 on-line tool	finish-maching	*Meronymy*			
monitoring		the method			
		Hyponymy			
		a feasible means			

Appendix IX:

The Analysis of Cohesion (Lexical Cohesion)

Text II:

A Flow Control Strategy for the Transmission of Variable Bit Rate Speech on Lan's

	A Flow Control Strategy	the Transmission of Variables Bit Rate speech on Lan's	Research
1.	*Repition* A flow control strategy	*Classification* Packet switched voice	*Meronymy* this Paper
2.			
3.		*Hyponymy* optimum network utilisation *Meronymy* speech qulity	
4.	*Meronymy* The performance of the flow control mehtod		*Meronymy* a simulation study
5.	*Repitition* The flow control method	*Meronymy* a prediction of the current talking/ silence state of all voice stations on the network	
6.	*Meronymy* A strategy for predicting the network traffic load *Meronymy* two methods of calculating station' s speech rate		

The Analysis of Cohesion (Lexical Cohesion)

Text III:

Instsnt-Chilled Steel Slag Aggregate in Concrete-Strength Related Properties

Properties	Instance-Chilled Steel Slag Sggregate	Other Aggregates	Tests	Description
Meronymy				
1 The properties of concretes containing instant chilled slag (I.C.S.) as aggregate				
Meronymy	*Repitition*			
2 good physical and mechanical properties	The I. C. S. slag			
Meronymy	*Hyponymy*			
3 sufficient stability	use as a coarse			
	Hyponymy			
	aggregate in concrete			
4 *Meronymy*		*Hyponymy*	Bond test	
5 higer interfacial bond splitting strength with cement mortar		limestone aggregate		
Hyponymy		*Meronymy*		
6 the tensile splitting strength of slag aggregate		limestone		*Hyponymy* higher
Hyponymy		*Hyponymy*		*Hypo.* greater
7 Compressive, indirect tensile and flexral strength of I.C.S. concrete		corresponding control concretes containing limestone aggregate		

Appendix X

The Analysis of the Nominal Groups

Text I

Comprehensive Tool Wear Estimation in Finish-machining via Multivariate Time-Serise Analysis of 3-D Cutting Forces

1. Comprehensive	tool	Wear	Estimation	in	Finish-----Machining	
Epethet	Classifier	Classifier	Thing	Qualifier		
					Classifier	Thing

via	Multivariate	Time -Series	Analysis	of	3-D	Cutting	Forces
Qualifier							
	Classifier	Classifier	Thing	Qualifier'			
					Classifier	Classifier	Thing

2. finish-----machining	
Classifier	Thing

3. geometric	accuracy
Classifier	Thing

4. surface	quality
Classifier	Thing

5. the	tool	wear	at	the	minor	flank	and	nose	area
Deictic	Classifier	Thing	Qualifier						
				Deictic	Classifier	Thing		Classifier	Thing

6. This	paper
Deictic	Thing

7. an	investigation	into	"comprehensive"	tool	wear	estimation
Deictic	Thing	Qualifier				
			Epithet	Classifier	Classifier	Thing

including	flank-,	crater-,	minor	flank-,	and	nose----wear,
Postmodifier						
Process	Participnat					
Material						
	Classifier	Classifier	Classifier	Classifier		Classifier Thing

based on	an	analysis	of	dynamic	cutting	force	in	oblique	machining
Postmodifier									
Process	Participant								
Material	Goal								
	Die.	Thing	Qualifier						
			Class.	Classifier	Thing	Qualifier			
						Epithet	Thing		

8. The	force,	measured	in	terms	of	its	three	orthogonal	components
Deictic	Thing	Postmodifier							
		Process	Circumstance						
		Material	Manner						
			Qualifier						
						Deic.	Num.	Classifeir	Thing

9. trivariate	Autoregressive	Moving	Average	Vector (ARMAV)	time	series	models
Classifier	Classifier	Classifier	Classifier	Classifier	Class	Class.	Thing

10. these	dispersion	analysis (DA)
Deictic	Classifier	Thing

11. features	sensitive	to	the	rate	of	various	types	of wear
Thing	Post-modifier							
	Epithet	Qualifier						
		Deictic	Thing	Qualifier				
						Epithet	Thing	Qualifier
								Thing

12. The	results
Deictic	Thing

13. minor	flank	wear
Classifier	Classifier	Thing

14. a	critical	value
Deictic	Epithet	Thing

15. finish------	--machining,
Classifier	Thing (Verbal)

16. optimum	cutting	conditions
Epethet	Classifer (Verbal)	Thing

17. an	appropriate	tool	change	strategy
Deictic	Epithet	Classifier	Classifier	Thing

18. the	basis	of	minor	flank	wear
Deictic	Thing	Qualifier			
			Classifier	Classifier	Thing

19. The	result
Deictic	Thing

20. the	method
Deictic	Thing

21. a	feasible	meaning	for	on-line	tool	wear	monitoring	in finsh---	--machining
Deictic	Epithet	Thing(Verbal)	Qualifier						
				Class.	Class	.Class	Thing(V)	Qualifier	
								Classifier	Thing(V)

The Analysis of the Nominal Groups

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION PF VARIABLE BIT RATE SPEECH ON LAN'S

1. A	FLOW	CONTROL	STRATEGY	FOR	THE	TRANSMISSION
Deictic	Classifier	Classifer	Thing	Qualifier		
					Deictic	Thing

OF	VARIABLE	BIT	RATE	SPEECH	ON	LAN'S
Qualifier						
Qualifier'						
	Classifier'	Classifier'	Classifier'	Thing'	Qualifier"	
						Thing

2. A	flow	control	strategy	for	packet	switched	voice
Deictic	Classifier	Classifier	Thing	Qualifier			
					Classifier	Classifier	Thing

3. this	paper
Deicitc	Thing

4. such	a	way	as to	achieve	an	optimum	network utilisation
Deictic	Dei	Thing	Postmodifier				
			Process	Goal			
				Dei.	Epithet	Classifier	Thing

5. speech	quality
Classifier	Thing

6. The	performance	of	the	flow	control	method
Deictic	Thing	Qualifier				
			Deictic	Classifier	Classifier	Thing

7. a	simulation	study
Deictic	Classifier	Thing

8. The	flow	control	method
Deictic	Classifier	Classifier	Thing

9. a	prediction	of	the	current	talking /	silence	state
Deictic	Thing	Qualifier					
		Deictic	Classifier	Classifier	Classifier	Thing	

of	all	voice	stations	[on	the	network
Qualifier						
Qualifier'						
	Epithet'	Classifier'	Thing'	Qualifier"		
				Deictic"	Thing"	

10. A	strategy
Deictic	Thing

11. the	network	traffic	load
Deictic	Classifier	Classifier	Thing

12. two	methods	of	calculating	each	station's	speech	rate
Numerative	Thing	Qualifier					
		Classifier	Epithet	Possessive	Classifier	Thing	

Appendix X

The Analysis of the Nominal Groups

Text III

INSTANT-CHILLED STEEL SLAG AGGRATE IN CONCRETE-STRENGTH RALATED PROPERTIES

1. INSTANT-CHILLED	STEEL	SLAG	AGGREGATE
Epithet	**Classifier**	**Classifier**	**Thing**

[IN	CONCRETE -	STRENGTH	RELATED	PROPERTIES]
		Qualifier		
	Classifier	**Classifier**	**Classifier**	**Thing**

2. The	properties	of	concretes	containing	instant-chilled	steel	slag (I.C. S.)
Deicitc	Thing	Qualifer					
			Thing		Post-modifier		
				Process	Participant		
				Possession	Possessed		
					Classifier	Classifier	Thing

as aggregate
Qualifier
Post-modifier
Circumstance
Means

3. The	I.	C.	S.	slag
Deictic	Classifier	Classifier	Classifier	Thing

4. good	physical	and	mechanical	properties
Epithet	Classifier		Classifier	Thing

5. sufficient	stability	for	use	as	a	coarse	aggregate	in	concrete
Epithet	Thing	Qualifier							
			Thing	Qulifier'					
				Deictic	Classifier	Thing	Qualifier"		
									Thing

6. Bond	tests
Classifier	Thing

7. I.	C.	S.	slag
Classifier	Classifier	Classifier	Thing

8. higher	interfacial	bond	splitting	strength
Epithet	Epithet	Classifier	Classifier (Verbal)	Thing

9. cement	mortar
Classifier	Thing

10. that	of	limestone	aggregate
Deictic	Qualifier		
		Classifier	Thing

11. The	tensile	splitting	strength	[of	the	slag	aggregate]
Deictic	Classifier	Classifier (V)	Thing	Qualifier			
				Deictic		Classifier	Thing

12. that	[of	limestone]
Deictic	Qualifier	
		Thing

13. Compressive,	indirect	tensile	and	flexural	strengths	of	I.	C.	S.	slag	concretes
Epithet	Class.	Classifier		Class.	Thing	Qualifier					
							Cl.	Cl.	Cl.	Cl.	Thing

14. those	of	corresponding	control	concretes	containing	limestone	aggregate
Deicitc	Qualifier						
	Classifier(V)		Classifier	Thing	Post-modifier		
					Process	Participant	
					Possession	Possessed	
						Classifier	Thing

The Analysis of the Lexical Density

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

Abstract

1. In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area.

2. This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.

3. The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models.

4. Based on these,

5. dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear.

6. The results show

7. that minor flank wear reaches a critical value first in finish-machining,

8. so that optimum cutting conditions or an appropriate tool change strategy 157
(90 91 92 93 94 95 96)

must be determined on the basis of minor flank wear.
(97 98 99 100 101)

9. The results also show
(102 103 104)

10. that the method is a feasible means for on-line tool wear monitoring
(105 106 107 108 109 110 111)

in finish-machining.
(112 113)

The analysis results:

Words: 166

Lexical Items: 113

% : 68%

Lexical Density = Lexical Items / Numbers of Clause

Lexiacl Density = 113 / 10
= 11.3

Appendix XI

The Analysis of the Lexical Density

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT
1 2 3 4 5 6

RATE SPEECH ON LAN'S
7 8 9

ABSTRACT
10

1. A flow control strategy for packet switched voice is introduced
11 12 13 14 15 16 17

2. and described in this paper.
18 19

3. It is designed in such a way as to achieve an optimumn
20 21 22 23 24

network utilisation and speech quality.
25 26 27 28

4. The performance of the flow control method is evaluated
29 30 31 32 33

by means of a simulation study.
34 35 36

5. The flow control method relies on a prediction of the current talking / silence state
37 38 39 40 41 42 43 44 45

of all voice stations on the network.
46 47 48 49

6. A strategy for predicting the network traffic load and two methods of calculating each
50 51 52 53 54 55 56 57 58

station' s speech rate, are simulated.
59 60 61 62

The analysis results:

Words: 86

Lexical Items: 62

% :72%

Lexical Density = Lexical Items / Numbers of Clause

Lexical Density = 62 / 6
= 10.3

Appendix XI

The Analysis of the Lexical Density

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Abstract

1. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented.

2. The I.C.S. slag possesses good physical and mechanical properties

3. and has sufficient stability for use as a coarse aggregate in concrete.

4. Bond tests have shown

5. that I.C.S.slag exhibits higher interfacial bond splitting strength with cement mortar than that of limestone aggregate.

6. The tensile splitting strength of the slag aggregate itself is higher than that of limestone.

7. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate.

The analysis results:

Words: 107

Lexical Items: 76

% : 71%

Lexical Density = Lexical Items / Numbers of Clause

Lexical Density = 76 / 7

= 10.9

The analysis of the Grammatical Intricacy

Text I

Comprehensive tool Wear Estimation in Finish-Machining via Multivariate Time-Series Analysis of 3-D Cutting Forces

1. ||| In finish-machining, geometric accuracy and surface quality are adversely affected by the tool wear at the minor flank and nose area |||.

2. ||| This paper describes an investigation into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining |||.

3. |||The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models |||.

4. β ||| Based on these,
   x α || dispersion analysis (DA) was used to extract features sensitive to the rate of various types of wear |||.

5. α |||The results show||
   ξ β α ||that minor flank wear reaches a critical value first in finish-machining ||,
   x β ||so that optimum cutting conditions or an appropriate tool change strategy must be determined on the basis of minor flank wear |||.

6. α |||The results also show
   x β ||that the method is a feasible means for on-line tool wear monitoring in finish-machining |||.

Appendix XII

The analysis of the Grammatical Intricacy

Text II

A FLOW CONTROL STRATEGY FOR THE TRANSMISSION OF VARIABLE BIT RATE SPEECH ON LAN'S

ABSTRACT

1. 1 |||A flow control strategy for packet switched voice is introduced

   + 2 and described [in this paper] |||.
2. |||It is designed in such a way as to achieve an optimum network utilisation and speech quality |||.

3. |||The performance of the flow control method is evaluated by means of a simulation study |||.

4. |||The flow control method relies on a prediction of the current talking / silence state of all voice stations on the network |||.

5. |||A strategy for predicting the network traffic load and two methods of calculating each station's speech rate, are simulated|||.

Appendix XII

The Analysis of the Grammatical Intricacy

Text III

INSTANT-CHILLED STEEL SLAG AGGRAGATE IN CPNCRETE-STENGTH RELATED PROPERTIES

1. |||The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented|||.

2. 1 |||The I.C.S. slag possesses good physical and mechanical properties
   + 2 ||and has sufficient stability for use as a coarse aggregate in concrete |||.

3. α |||Bond tests have shown
   x β ||that I.C.S.slag exhibits higher interfacial bond splitting strength with cement mortar than that [of limestone aggregate |||.

4. |||The tensile splitting strength of the slag aggregate itself is higher than that of limestone |||.

5. |||Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding control concretes containing limestone aggregate |||.

The Analysis of the Grammatical Metaphor

Text I

Comprehensive tool Wear(1) Estimation(2) in Finish(3)-Machining(4) via Multivariate Time-Series Analysis (5) of 3-D Cutting(6) Forces

Abstract

1. In finish-machining, geometric accuracy(7) and surface(8) quality(9) are adversely affected by the tool wear at the minor flank and nose area.
2. This paper describes an investigation(10) into "comprehensive" tool wear estimation, including flank-, crater-, minor flank-, and nose-wear, based on an analysis of dynamic cutting force in oblique machining.
3. The force, measured in terms of its three orthogonal components, was used to develop trivariate Autoregressive Moving Average Vector (ARMAV) time series models (11).
4. Based on these,
5. dispersion(12) analysis (DA) was used to extract features sensitive to the rate(13) of various types of wear.
6. The results(14) show
7. that minor flank wear reaches a critical value(15) first in finish-machining,
8. so that optimum cutting conditions or an appropriate tool change(16) strategy must be determined on the basis(17) of minor flank wear.
9. The results also show
10. that the method is a feasible means(18) for on-line tool wear monitoring(19) in finish-machining.

Appendix XIII

The Analysis of the Grammatical Metaphor

Text II

A FLOW(1) CONTROL(2) STRATEGY(3) FOR THE TRANSMISSION(3) OF VARIABLE(4) BIT RATE(5) SPEECH(6) ON LAN'S

1. A flow control strategy for packet(7) switche(8)d voice is introduced
2. and described in this paper.
3. It is designed in such a way as to achieve an optimum network utilisation(9) and speech quality.(10)
4. The performance(11) of the flow control method(12) is evaluated by means of a simulation(13) study(14).
5. The flow control method relies on a prediction(15) of the curren(16)t talking(17) / silence(18) state of all voice stations on the network.
6. A strategy(19) for predicting(20) the network taffic load(21) and two methods(22) of calculating(23) each staion's speech(24) rate(25), are simulated

Appendix XIII

The Analysis of the Grammatical Metaphor

Text III

INSTANT-CHILLED STEEL SLAG AGGREGATE IN CONCRETE - STRENGTH RELATED PROPERTIES

Abstract

1. The properties of concretes containing instant-chilled steel slag (I.C.S.) as aggregate are presented.
2. The I.C.S. slag possesses good physical and mechanical properties
3. and has sufficient stability(1) for use(2) as a coarse aggregate in concrete.
4. Bond tests(3) have shown
5. that I.C.S.slag exhibits higher interfacial bond splitting(4) strength(5) with cement mortar than that of limestone aggregate.
6. The tensile splitting strength of the slag aggregate itself is higher than that of limestone.
7. Compressive, indirect tensile and flexural strengths of I.C.S. slag concretes were greater than those of corresponding(6) control(7) concretes containing limestone aggregate.